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# AIR FORCE Civil Engineer

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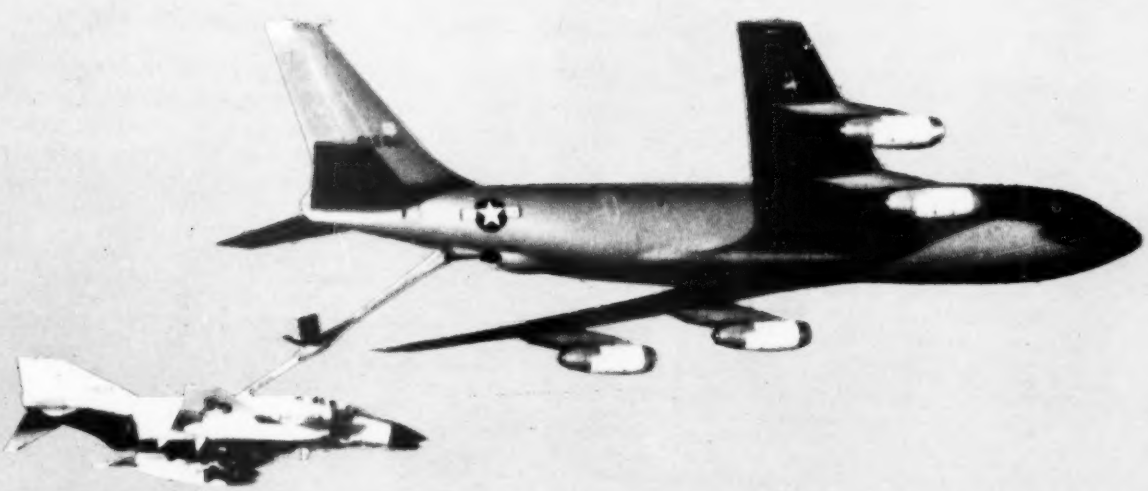

# AIR FORCE Civil Engineer

USAF RECURRING PUBLICATION CE 85-1 VOL 13 NO 4 NOVEMBER 1972



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The AIR FORCE CIVIL ENGINEER is an official, non-directive HQ USAF publication, published quarterly under provisions of Chapter 2, AFM 5-1. Its purpose is to provide timely information to Air Force Civil Engineering personnel relating to mission accomplishment; to assist them in solving problems and improving efficiency of operation; to communicate new developments and techniques, and to stimulate professional thought and development. The Journal is edited and published by the Civil Engineering School, Air Force Institute of Technology. Contributions, suggestions and criticism are welcome.

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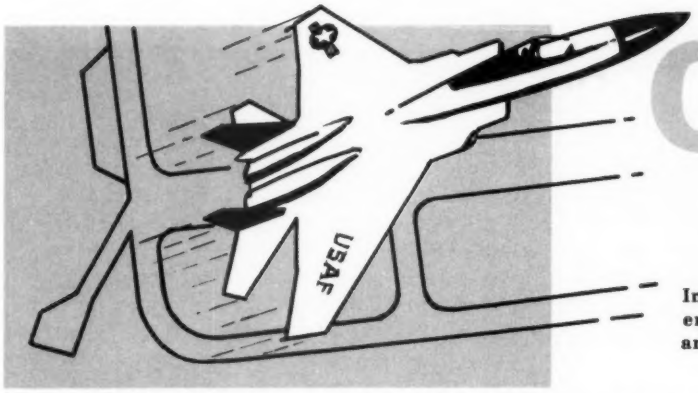



# Current Emphasis

**Information published here is designed to keep civil engineering personnel aware of late developments and significant trends within the career field.**

HOUSING IMPROVEMENTS--Viable programs for Post-Acquisition Construction and Minor Construction are available for improvement work, and all such projects should be budgeted using P-713 funds. Foreseen improvement projects should not be budgeted for O&M funds.

GOOD COMPUTER NEWS--B3500 functional users can accomplish special reports using good old English instead of the usual automation lingo. A functionally operated automation product generator has been implemented at all B3500 bases. The Base Level Inquiry System (BLIS), documented in AFM 171-114, allows B3500 functional users to generate special reports in their own formats to suit unusual requirements and in a short time. Documentation to operate this system, which must suit Civil Engineering's needs, has been written and successfully tested at all major commands with B3500 computers installed. Tasks remaining are to enable major commands with H800/200 computers installed to use BLIS on their base B3500s and to provide procedural documentation for all B3500 bases.

LIVES SAVED--The Firefighter Rescueman Course (2ASR57150-3), in its first year of operation at the Fire Protection School, Chanute AFB, has graduated 315 students. So far, it has been documented that three lives have been saved because of the special techniques taught in the course.

PRIME BEEF CHANGES--New procedures to evaluate a mobile Prime BEEF team's deployment capability have been published in AFM 93-3. Base level management of the Prime BEEF program should familiarize themselves with the new "C" rating criteria to insure accuracy in mobility status report.

DON'T DO IT--Some installations have connected industrial waste discharges to sanitary collection systems without regard to the effect on water treatment facilities. Waste waters should not be discharged to the domestic system without assuring their compatability with type of treatment provided. Assimilation problems affecting treatment process are outlined in AFP 161-20.

FAUCET CARTRIDGES--Tests have indicated a substantial reduction of maintenance calls by the use of metallic cartridge type faucets. They are approved for use and are covered in Federal Specification WW-P-541. While the first cost of cartridge faucets are higher than familiar types, the lifetime cost indicates a 30% saving over conventional units. Where brass valve seats have failed by erosion-corrosion in conventional faucets, use valve seats fabricated from Monel instead of brass replacements.

IMPROVEMENTS COMING--A solid waste management study, started in September at Offutt AFB, will include field sampling and analysis of all base solid waste materials. This project is designated to evaluate the overall solid waste management program and present recommendations (Continued on next page).

for necessary improvements to develop a model base solid waste management system.

HELP FOR THE FUNDS MANAGER--Are you associated with the management of funds in your job? If so, your star is rising in the spotlight. Reduced appropprias-tions require scrutiny of the budget and tighter management of individual funds. Help is on the way! AF/PREM has requested assistance from the Air Force budget people to conduct seminars at bases to aid you in your job. It will take a lit-tle time to get organized, and until then, you can get a great deal of knowledge from AFM 178-6, Resource Manager's Handbook, dated July 1972. In laymen's terms, it explains the Air Force budget and the concept of funds management. Getting acquainted with this Handbook will go far in helping the Civil Engineering funds manager in his job.

PROGRAMMING MANUALS--The best test of AFM 86-1, recently published, will be in its implementation at base and command. All comments, sent directly to AF/PREP, along with evolving program guidance, will form the basis for early re-visions.....AFM 86-2 will be issued next month. It is changed from AFM 86-4 and will include new criteria on religious, welfare and recreation facilities. The criteria adds many new categories and expands the scope previously allowed against existing categories.

HELP FOR CORROSION ENGINEERS--The Air Force Civil Engineering Center, Tyndall AFB, will assist command corrosion engineers in preparing corrosion oriented programs under new AFR 91-27.

STAFF BCE COURSE--Major command civil engineers are personally selecting Base Civil Engineers and Deputies to attend the Staff BCE course at the Civil Engineering School. Just a reminder: CES courses are accredited at the Univer-sities of Wisconsin and Nebraska for the Professional Development Degree Program.

PEST MANAGEMENT--The Federal Working Group on Pest Management has held work-shops on the CY 73 pest control programs. Bases are advised to plan their CY 73 programs and to prepare for the call for this program. AF/PREV is represented on the Program Review Panel of the Federal Working Group.

VEHICLE EQUIPMENT EVALUATION--The Management Evaluation Program (MEP) is an effective method of evaluating vehicles and/or equipment items for possible Air Force application. Under this program, vehicles and/or equipment items are loaned to the Air Force by the manufacturer during an evaluation period at no cost or obligation to the government through an in-bailment agreement. All re-quests for MEP projects should be submitted to AFCEC/EQ, Tyndall AFB, FL 32401, where they will be reviewed and forwarded through the appropriate channels for project establishment.

P-4 FIRE TRUCK TRAINING--The Fire Protection School at Chanute AFB reports that it is awaiting approval of traveling teams for on-site operator training of P-4 fire vehicles. Procedures for securing training by the traveling teams will be: Submit all requests through the respective major command by filling out Air Force Form 403. Major commands will forward the requests to Headquarters Air Training Command which will then forward the requests to the Fire Protection School. In the meantime, bases can avail themselves of the two-week resident course now in operation at the Fire Protection School.

REPORTING ENTRY LEVEL AIRMEN--A recent all major command letter allows 010 airmen to be assigned to an Exception Time Accounting (ETA) Cost Center (CC) while remaining physically in their parent cost centers for work purposes as free labor.

**Ice thickness over the Arctic Ocean is now at a critical stage. The average thickness is about six to eight feet. . . . The prediction has been made: the Arctic Ocean will be ice free by the turn of the century and will remain an open ocean. A noted Air Force Arctic authority discusses . . .**

# Operations in the Arctic Environment: Yesterday, Today and Tomorrow

**by Col Bernt Balchen, USAF, (Ret)**

The melting and disappearing of the Polar pack ice over the Arctic Ocean is a process which, when completed, will have important consequences concerning the transportation of oil and minerals from the Arctic Regions to the United States and other markets of the world. It will also open up new shipping lanes from Europe to the Far East and will save the distance traveled now by an average of almost 60 percent. In addition, it will affect the climate of the surrounding land areas, causing colder and heavier snowfalls during the winters, and will create water deficiencies in the latitudes of the United States and similar latitudes in Europe and Asia.

The North American interest in the Arctic Regions must be seen from the geographic position of these areas as the center of the population and the industries of the Northern Hemisphere. The following three important points must be considered:

- Economic: Exploitation of oil and minerals; and transpolar shipping lanes between Europe and the Far East.
- Military: Defense against air and seaborne attrition across these regions.
- Climatic: Serious consequences of the vanishing of the pack ice shield over the Arctic Ocean.

Prof. H. W. Ahlmann of the University of Upsala, Sweden, presented a paper at a geophysical conference in Sweden in 1953, that stated the ice cover over the Arctic Ocean is degrading. He cited the cause as the continual inflow of carbon dioxide to the air over the Arctic Ocean which is the result of volcanic eruptions in the Northern Hemisphere over the last 1500 years. The pollution of the Arctic air binds the heat from the rays of the sun, which warms up the air, and consequently results in melting of the pack ice.

Professor Ahlmann predicted that if this trend continues, the Arctic Ocean will be ice free by the turn of this century, and will remain an open ocean. His prediction has been supported by other scientific authorities.

*(Cont'd next page)*

# Arctic Environment
*cont'd*

An albedo of 60 to 80 percent limits the absorption of the incoming heat to keep the ice cover in balance; it acts as an inhibitor of the heat exchange between the overlaying air and the underlying water. Heat budget calculations give rise to the belief that a reduction of summer albedo of the pack ice from 70 to 60 percent would melt it in nine to 10 years. A reduction to 50 percent would do so in two to three years. A summer air temperature increase of 10 degrees F would melt the ice in no more than two years and an increase of five degrees would do it in a few decades.

In the last 29 years, Thule AB, Greenland, had opened up for resupply by sea from about mid-August to mid-September. Today, Thule AB is open from about the latter part of June until November.

The following are ice conditions which were observed on a flight from Thule AB to Point Barrow, Alaska on 4 July 1968:

- Thule AB to East Side of Devon Island: Slush ice with large basins of open water; Lancaster Sound open to Brodeur Peninsula and to Bear Bay in James Sound.
- Devon Island to West Side Banks Island: Solid ice cover, long cracks, large melt pools; whole ice surface is waterlogged and cored. Estimated albedo is 50 percnt fast deteriorating surface.
- Bank Island to Point Barrow: Large, open leads running east to west. Some are 10 to 12 miles wide and up to 100 miles long; ice is thin with numerous melt pools, and waterlogged with slush and open pools over most of the surface.

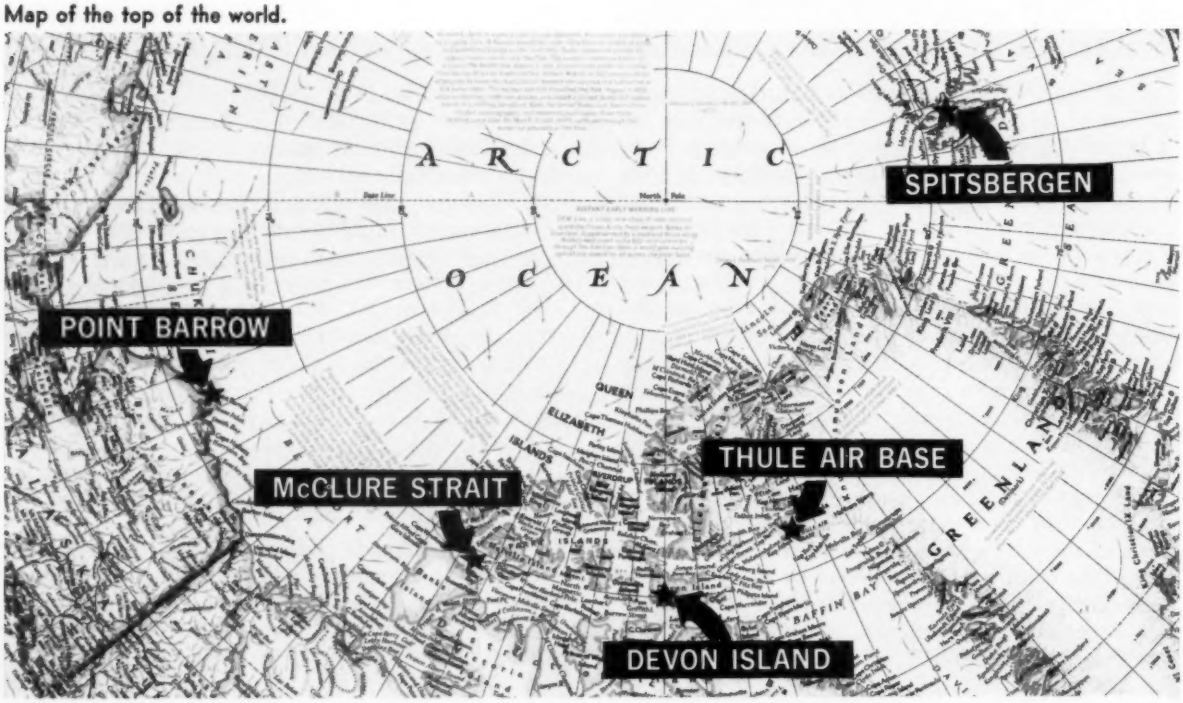
The polar ice pack, when pushed by wind, opens up leads. With a southerly wind, this could leave an open passageway all along the northern coastline into the Beaufort Sea. This is a situation which this writer neither had seen nor heard of previously, but which did occur in 1968. When viewed in connection with the large flush out of ice between Spitsbergen and Greenland in March 1968, it can lead to a possible opening up of the Arctic Ocean in the near future.

In July 1969, ice free water flowed completely along the west coast of Greenland up to the Arctic Ocean through Baffin Bay, Kane Basin and Robeson Channel. The following was observed on a 10 July 1969 flight from Thule AB to Point Barrow:

- Lancaster Sound was open from Baffin Bay to the west of Cornwallis Island.
- Slush ice covered the Mellville Sound area.
- McClure Strait had slush ice with open leads, and was open to the Beaufort Sea.
- Prince of Wales Sound was open along the shorelines with floating slush in the center.
- Amundsen Gulf and Beaufort Sea had large bodies of open water. From the Beaufort Sea to Point Barrow, the water was covered by floating, thin pack ice which could not be of any consequence to ice reinforced ships.

Ice conditions recorded between Spitsbergen and

Map of the top of the world.



Point Barrow in 1970 revealed open water between Spitsbergen and Greenland; sporadic light ice in the Greenland Sea; a mild winter in Spitsbergen and northern Norway, with light precipitation; and the most severe winter on record in southern Norway, with heavy snowfalls and low temperatures on the western central coast. As a result of these conditions, the concensus is that the pack ice north of Spitsbergen is degrading in thickness.

Other observations recorded in 1970 showed open water with some light ice debris floating between Thule AB and Devon Island, Jones Sound; broken ice at Smith Sound and Kane Basin; and light ice conditions along the northern coast of Greenland. Further conditions reported during the same year revealed that the entrance to Lancaster Sound was open with some light cored ice; at Barrow Strait, there were cracks and leads, no pressure ridges observed, and ice was thin, puddled and watersoaked; there was thin ice at Mellville Sound, with leads increasing in number and size; ice coverage was decreasing at Dundas Peninsula, with large patches of open water; McClure Strait had open water with some brash ice floating; the Beaufort Sea was open to the south and north, with only light ice to the west; and Point Barrow had light ice to the west, and open, large bodies of water in the Chucksi Sea, and to the north.

Another important factor under observation lately is the possible upwelling of Atlantic waters from depths of about 600 feet to the surface, which destroy the critically thin ice shield. The upwelling can accelerate the disappearance of the Polar ice at a faster rate than the air pollution. An example of the effect of this upwelling is a report by a Soviet ice station, located at approximately 80 degrees north and 180 degrees, that Russian fishermen had taken in a catch of 14,000 codfish from a depth of 30 feet. The upwelling of Atlantic waters also has been observed outside Spitsbergen. This upwelling of Atlantic waters in the Arctic Ocean could reduce or stop the growth of the ice cover, thereby eliminating the ice shield in a short time.

The ice thickness over the Arctic Ocean is now at a critical stage; the average thickness is about six to eight feet, covering an area from five to three and one-half million square miles in winter and summer.

Factual, recorded information on the degradation of the ice pack is shown in **Figure 1.**

A listing of the break-up and closing times at Point Barrow are as follows:

- Break-up of ice: 15 June, early; 22 August, late.
- Freeze up of ice: between 2 September and 17 December; average between 1 and 5 October.
- Break-up, 1968: in March; Freeze up, 1968: in November; Break-up, 1969: in February.

In February, 1968, there was large outflow of heavy Polar pack ice between Greenland and Spitsbergen, which blocked the northern coast of Iceland from March until May. It blocked the east coast of Greenland for the entire summer until late in the fall, and prevented shipping to Spitsbergen, Bear Island, Jan Mayen and the eastern coast of Greenland until late in the fall. The Norwegian Polar Institute estimated that 30 to 40 percent of the Polar pack ice had drifted out into the Greenland Sea.

**BERNT BALCHEN** *piloted Admiral Byrd to the Antarctic in 1928 and, since that historic expedition, has become one of the most listened to experts of frozen lands. He also was one of the pilots on Byrd's flight across the Atlantic in the first tri-motored aircraft. He was commissioned into the US Air Forces in 1941, recalled to active duty in the Air Force in 1948 and later became a special assistant on Arctic problems to the Air Force Chiefs of Staff. Numerous books have been written about him and he himself has authored several. Educated in the Norwegian War Academy, he received the honorary doctor of science degree from Tufts College and the University of Alaska.*

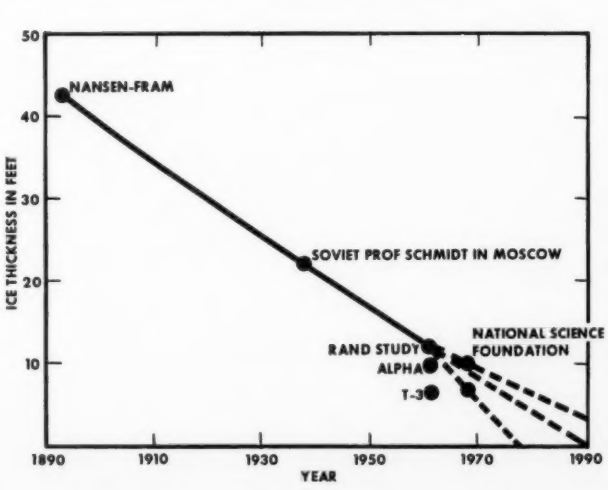
At the present time, the climate of the Arctic Regions can be described as a desert, with rcorded annual precipitation of about nine and one-half inches. The climate is also much milder than the surrounding Arctic and Subarctic land areas, the result of the presence of open water leads occurring all the time, even at the North Pole in midwinter. This presence of open water is the ameliorating temperature factor.

The ice plate, which has up until now covered the Arctic Ocean with a relatively cold surface, has caused a high pressure area to be situated over the Arctic all year-round. This Arctic high pressure deflects the cyclonic system originating over the North Pacific to a more southerly pass across the agricultural areas of the United States and Canada.

Calculations indicate that if the pack ice were to disappear, the following conditions would probably prevail:

*(Cont'd next page)*

**Figure 1: Degradation of the Arctic ice pack.**



# Arctic Environment
*cont'd*

1. The Arctic Ocean surface temperature in the coldest months would be about 42 degrees F. The pack ice would not form again.

2. Mid latitude climates would be 20 to 25 degrees warmer than now. Low latitudes would be 10 degrees F cooler in winter.

3. The cyclones of the Northwest Pacific would be deflected northward into the Arctic Ocean and would form a low pressure system. The moist air from these lows would increase annual snowfalls another eight to 10 feet in the Arctic and Subarctic land areas. It would affect Alaska, Northern Canada, the Atlantic Northern Seaboard, Central Greenland and Scandinavia. The Soviet Union would be similarly affected. Cold winters would be expected in Northern United States and Canada. The central part of the United States would get dry winters with a large water deficiency.

The last two winters have been severe over the belt indicated in paragraph 3. Norway has had three of the most severe winters on record with heavy snowfalls and low temperatures. Spitsbergen and Northern Greenland have had light snowfalls and mild temperatures, with these same conditions prevailing at Point Barrow.

With its low density of human and animal populations, the ecology of the Arctic Regions will be expected to follow the history of the intrusion of the modern technological and aerospace age. The stone age culture will have to give way to the new age.

The five and one-half million square miles of Arctic Ocean—until now 75 percent or four million square miles—is covered all year-round. It is now estimated to have an all year-round ice cover of about three and one-half million square miles or 63 and one-half percent.

C-141s of Military Airlift Command fly all types of cargo into cold regions. Here a load of foodstuffs is unloaded.

An ice-free Arctic Ocean, with heavy snowfalls over the littoral zones and also cold winters in these areas, will create operational problems, such as docking and navigating, for these areas. They should be well within our technological capabilities to solve.

An ice-free Arctic Ocean between the North American continent and the Soviet Union creates an operational control responsibility as well as a military responsibility of defending these areas against sea and air attrition, should such a requirement arise in the future. It should require a close study of what type weapons systems—aircraft as well as naval vessels reinforced for operations in these environments—to meet the new tasks in the high Arctic. These will be needed in the near future. CE

Photographs reproduced throughout this article were provided by the *Air University Review*, Maxwell AFB, Alabama.

**Over 55 miles of joints were repaired and over 35 tons of joint seal were used to correct an unsatisfactory situation at Mather Air Force Base, California.**

# Innovative Repair Project Keeps the Aircraft Flying

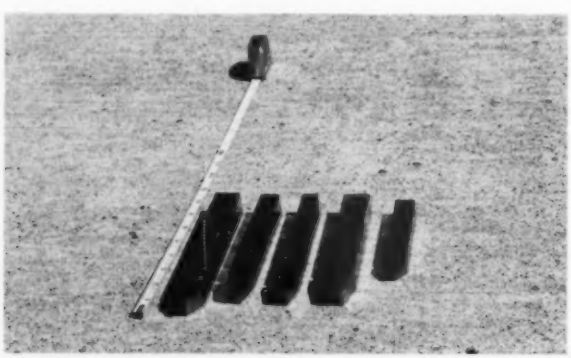
by Bruce C. Gandy, PE

An innovative project that involved the removal and replacement of deteriorated joint seal in the 15,000 foot primary taxiway and the 6,000 foot concrete portion of the primary instrument runway, to a depth of ¾ inch, was recently completed at Mather AFB, California. Over 55 miles of joints were repaired, requiring more than 35 tons of joint seal. In addition, approximately 1,500 square feet of spalled areas along the joints were cut out and repaired.

The primary mission of Mather AFB is the training of navigators. During the repair work, the T-29 aircraft used for training purposes, landed and took off from the shorter parallel runway; however, since the base is also the host for a SAC bombardment wing tenant, it was necessary that the primary runway be in such condition that B-52 aircraft could take off in case of an emergency. Since the runway is 300 feet wide, Mather AFB civil engineers decided to split it down the middle for working operations which allowed a 150 foot runway for emergency use. Also, engineers worked one-half of the length of the taxiway at a time, starting at the parking access which permitted aircraft to reach one end of the runway. As time was less critical on the taxiway, the spalls were repaired with less expensive high early strength Portland cement, while those on the runway were repaired with epoxy concrete, in the interest of expediency.

The last project of this type (repairs were made at the SAC apron in 1966) had resulted in considerable dissatisfaction with the joint cleaning equipment; edges of the joints were torn badly, and a loss of approximately $30,000 was recorded because of the failure of the epoxy patches. Because of this past history, Mather AFB civil engineers investigated the experiences of other bases in this type of work. They learned that, because of the long intervals of time between work at any one base, very little experience was gained by any one individual, and usually, much of the experience of those contacted had been unsatisfactory. There seemed to be no way to obtain a satisfactory joint for the installation of new joint seal except to plow out the old seal with a steel blade and then revert to the slow and expensive method of concrete saws and sandblasting.

Carbide inserts in the various shaped cutting tools used in the repair project at Mather AFB are clearly visible.



Investigation finally uncovered a new type of tool which had been used at some commercial airports with remarkable results. Developed by a Washington state construction company, the tool of carbon steel had an insert of silicon carbide for the cutting edges. It was amenable to being ground to shape to fit the joint on which it was to be used, thus retaining its shape over a prolonged period of time. This offered a distinct advantage for the repair work at Mather AFB since joints were sawed ¼ inch wide with edges chamfered to a flat V. It was found that the tendency of the tool is to become rounded at the edges which then would tear the concrete.

### Tool Placed at Rear of Tractor

The tool is placed in a movable holding device at the rear of a Fordson tractor. It is held at an angle of about 30 degrees from the vertical, the top forward from the cutting edges, providing a slicing action rather than a tearing or gouging action, of the concrete. The tool and holder are free to move laterally to follow the joint. It is hinged so it can be raised vertically to be placed in the joint. Once placed, the assembly is under the influence of a pressurized hydraulic cylinder which, when given a few pump strokes by the operator, applies the required pressure to hold the tool in the joint. The tool removes the joint seal and a thin slice of the concrete, leaving the joint clean and ready for the new seal.

Where joints had been overfilled to hold spalled concrete particles in place and prevent their being sucked into jet engines, a new shape tool was prepared. These tools were square at the bottom with carbide inserts and were placed one on each side of a dulled joint plow tool. The dull tool would follow the joint while the two flat-bottomed tools would clean the pavement surface to a distance of ¾ inch on each side of the joint, thus allowing workers to dispense with sandblasting.

Our description of joint cleaning tools in the specifications was written around the above tools and the final results were excellent. In the final analysis, the cost was nine and one-half cents a lineal foot as against a cost of 22 to 24 cents a foot for conventional methods, a savings in excess of $35,000.

Since the experience with epoxy concrete in 1966 and the inability at that time to disprove some of the contractor's contentions, Mather AFB civil engineers performed considerable research and experimentation with epoxy concrete in cooperation with the California State Highway Division. A mix design had been formulated which produced samples so high in compressive strength that they were unbroken on our concrete

compression tester at 50,000 psi. This mix used crushed coarse aggregate, 95 to 100 percent passing the ⅜ inch screen, with 95 percent of that passing the screen retained on the No. 8 screen. Fine aggregate was 30-grit, bagged, hard, clean, sharp sand. The mix was four parts by volume of coarse aggregate, three parts fine, one part Portland cement and two parts epoxy resin. This mix readily flowed and did not require tamping. It was placed on a tacky epoxy resin coating which was either sprayed or brushed on the concrete to be repaired.

Mather AFB civil engineers had planned to use Federal Specification SS-S-164 joint seal, a non-jet-fuel-resistant type; but after bids were let, Headquarters US Air Force decided that jet-fuel-resistant SS-S-167 should be used in the 1,000 foot ends of the runway. This was a more expensive material and the civil engineering specification called for the use of a breaker strip in the joint to prevent the "incompatible" seals from touching. As the three cents a foot for breaker strip material and the five cents for deeper joints and installation would run into a considerable amount of money and lengthen the contract period, it was decided that some investigation was warranted.

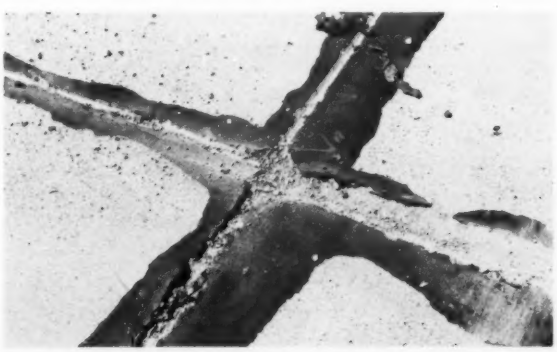
Since engineers had more than a week before the start of the SS-S-167 installation of joint seal, they placed a number of test samples and began calls of inquiry to the Corps of Engineers, Ohio River Test Center; Corps Sebastopol, California Laboratory; the manufacturers of joint seal; and commercial laboratories. The Corps and the manufacturer ran tests. Soon afterwards, Mather AFB civil engineers began to receive results which were similar to those of their own tests. There was no chemical action between the two seals but they would not adhere to each other. Mather AFB civil engineers did not consider this an obstacle since, with the use of a breaker strip, there would be no adherence anyway. After explaining our reasoning and results of the tests to Headquarters Air Training Command, we were given a waiver in the use of the breakers.

To learn more about joint seals, the head of the Pavements and Grounds Section and the Base Pavements Engineer at Mather AFB visited the manufacturer's plant. They learned much from the company's laboratory chief and gathered some information about hot-poured joint seals, which might explain some of the failures experienced at other bases. Joint seals are not complete when received at the job site; they must reach a certain temperature before they will cure in the joints, and can only be brought to this temperature once. Unless the seal is brought to the recommended temperature and maintained at that temperature during the pouring procedure, the seal will not cure but will remain sticky and semi-fluid. After the third day of curing, the sealant should eject a 25 cent piece pushed half its diameter into the seal with no seal adhering to the coin.

The project was completed within the alloted time. The final figures showed that if Mather AFB civil engineers had used the conventional methods from the 1966 project and the unit costs (plus inflation) from the low bid for that job, the cost for the present project would have been in excess of $150,000. The final cost for this project, including the use of the more costly SS-S-167 joint seal and the repair of more square feet of spalls than had been estimated, was almost $65,000. Unit costs for the preparation of the joints for resealing were actually lower, using the new tools, than those in 1966. The result is a better repaired airfield surface. CE

**BRUCE GANDY** *is a Civil and Structural Engineering Technician, 3535 Navigational Training Wing, Mather AFB, California. A frequent contributor of articles to the Journal, he is a registered Professional Engineer in Massachusetts. He was recently named as one of 10 individuals in the United States to receive the Air Force Economy Award.*

Removal of old joint seal in both spalled and unspalled areas are shown. Note clean cut where concrete is sound.



A spalled area is shown of the joint seal placed by personnel to hold the concrete particles in place.

Two step housing at Bergstrom Air Force Base, Texas, stresses individual carports, additional off-street parking, single story duplexes, rear lot electrical lines and exterior stucco finishes. One hundred units have been erected.

## Aggressive management by TAC engineers in a 250 unit construction program has resulted in . . .

# More and Better Housing for Air Force Families

by Thomas L. Lord, PE

How is the problem of construction cost escalation solved without sacrificing quality in military family housing? Tactical Air Command (TAC) has the answer: two-step procurement. The facts that support this are the 150 family housing units that were constructed at Luke AFB, Arizona, and the 100 units at Bergstrom AFB, Texas. Actual construction was six months ahead of schedule and the cost was $250,000 below the Government estimate.

Firm and aggressive management by TAC civil engineers was essential to this success. It rejected, without compromise, those proposals that did not measure up to Air Force standards. In itself, this was a new experience for many TAC engineers and required a change in thinking regarding Government contracts. TAC engineers were aggressive in that they took away the initiative of the bidders and moved from a passive to an active role in the procurement cycle.

The Luke AFB and Bergstrom AFB houses are three and four bedroom, single story duplex, airman's units with such features as carports, patios, two full baths, air conditioning and garbage disposals. Exterior finish is basically stucco with brick or PVC siding for accent. In addition to utilities, grading and streets, the sites have public sidewalks, curbs and gutters, asphalt streets and concrete driveways. The driveways are of sufficient size to provide an additional off-street parking space per unit. Except for the number of units, the work statements were basically identical for the two bases.

Since two-step procurement is a relatively new approach, TAC took the initiative to encourage contractor interest. Over 100 contractors were invited to pre-proposal conferences. About 30 attended and 15 submitted proposals, representing one of the best contractor responses in recent years for a military housing project. The success in receiving this type response was the positive involvement in a joint venture of TAC and base personnel, and the simplicity of the proposal request. By minimizing the cost for submitting a proposal and using standards familiar

These single story duplexes at Bergstrom AFB, Texas, have such features as patios, two full baths, air-conditioning and garbage disposals. One hundred and fifty of these units have also been constructed at Luke AFB, Arizona.

to the home building industry, it was possible to streamline the request for proposals, thus assuring sufficient interest to obtain competitive bids. The request for proposals (RFP), Step 1, consisted of a site design and a work statement. The site design established in detail utility mains, roads, grading and lot lines. This greatly decreased the cost to the contractor in submitting and bidding on his proposal. The work statement established FHA minimum Property Standards 300 for One and Two Living Units as the basic standard for construction. Additionally, the work statement defined the essential features of the project, quantity requirements (square footage, number of bathrooms, etc.) and acceptable materials (roof shingles, etc.).

Any proposal failing to meet essential requirements was rejected. Basically, there were six essential features.

1. The houses will be similar to those currently being constructed or previously constructed by the contractor in his normal course of business.
2. The housing units and site development must provide most nearly the optimum balance of architectural attractiveness, design, function, and low-cost maintenance and operation.
3. The distribution of floor area to spaces for food preparation, dining, living, sleeping, halls, closets and services should be in balance and reasonable for the purposes served.
4. A minimum of four variations in exterior elevations, exterior finishes and exterior colors were necessary.
5. Proposals must be fully and clearly acceptable without additional explanation or information, since the Government may make a final determination solely on the basis of the proposal as submitted and proceed with the second step without requesting further information.
6. The proposal must be reasonably susceptible of being made acceptable by additional information clarifying or supplementing, but not basically changing the proposal as submitted.

Based on the above essential features, proposals from seven contractors were rejected. In each instance these contractors were given the full and complete reasons their proposals were unacceptable. Here is where firmness, coupled with the fact that our basic responsibility is to the Air Force, is mandatory. Any deviation would probably result in a collapse of the two-step method by either opening the bidding to all contractors or cancelling the invitation for bid. This would result in the government either getting poor quality housing or being financially responsible for all submitted proposals.

The results of TAC's experience at Luke AFB and Bergstrom AFB indicate that the following approaches for two-step housing are desirable:

- Civil engineering and procurement must be firm and aggressive in the overall management aspects, in addition to possessing a firm conviction and commitment toward the benefits of two-step procurement. There is no room for negative feelings. TAC's success is mainly attributed to having the right type of people assigned on these projects.
- Contractor costs for preparing and submitting a bid must be minimal. The Air Force should provide the site design and use accepted industry standards (FHA).
- Do not give the contractor an option on material in the hope that we can get the "best for less." If brick is wanted instead of pre-finished siding, then tell the contractors. Remember this is a competitive bid.
- A technical evaluation team should review the project first against the essential features, then against the more detailed technical requirements. The results should then be presented to a selection board. Any proposal failing to meet any of the essential features should be rejected. No compromise is permissible.
- The step-one submittal should be kept as simple as possible concentrating on essential architectural features. Other items such as electrical or mechanical systems should be governed by performance type specifications.

The success of two-step housing lies in the fact that we use to maximum advantage the housing industry's expertise in designing and building houses of high quality, proven constructability and maximum durability, at minimum costs. By using a turn-key approach we are able to use the knowledge of local contractors, with respect to labor and local building materials and techniques to build a quality product of proven constructability and durability. By allowing contractors to submit proposals on proven "off the shelf" type designs for which the contractor was familiar, many of the unknowns such as material and labor cost inherent in the traditional design approach are known to the contractor.

TAC's two-step procurement is paying dividends to the Air Force and for military family housing. Six months early completion resulted in an additional collection of almost $300,000 in housing allowances. This, coupled with the initial savings in architect-engineer fees, government review costs, and the below government estimate bids, brought the total savings to over $600,000, or over $2,000 a unit! The final outcome is certainly more and better housing for military families. CE

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# AFCE Leaders You Should Know

## ... Col Warren E. Campbell

It's often been said that "first impressions are lasting impressions." And to Col Warren E. Campbell, the first impressions of approximately 100,000 men and women are of particular concern since they are the personnel who are recruited and trained annually by Air Training Command to man the Air Force's aerospace force.

As the DCS/Civil Engineering at ATC Headquarters, Randolph AFB, Texas, Colonel Campbell states his concern strictly from an engineer's viewpoint. "Our major problem is to provide for the upkeep and modernization of a physical plant which, for the most part, is outdated and in need of replacement. Our concern is the fact that ATC facilities provide a first impression to almost every person who enters the Air Force. The effect played by these facilities on these personnel in accomplishing the training mission is equally as important."

ATC is one of the largest military school systems in the free world. It owns 16 bases, operates from many others here and abroad, and has over 100 field training detachments. Its real property worth is tabbed at $1.6 billion and it employs almost 7,500 persons in its civil engineering organizations.

Colonel Campbell's primary responsibilities are the managerial leadership and technical guidance for the programming, design, construction, and operations and maintenance of the facilities; utilities; real property management; fire protection services; environmental protection; and contingency/mobilization planning.

There is no question in why he admits to this current assignment as the highlight—to date—in his 30 year military career. Behind him are the experiences of responsive positions which no doubt prepared him well to serve as the Chief Engineer of one of the Air Force's largest commands.

His immediate past assignment was as the Director of Operations and Maintenance at HQ USAFE, and prior to that, as the BCE at Wiesbaden, Germany. His HQ US Air Force experience includes duty as the Chief of the Management Branch, Maintenance Division, Directorate of Civil Engineering.

This background of experience unquestionably is reflected in his interesting assessment of the biggest challenges that AFCEs are facing today. "There is the necessity to improve the internal management of civil engineering resources," he said, adding "not in terms of more and bigger systems or computers but in terms of more 'attention to detail' as appropriate from each supervisory level. This is a two-way street involving the quality of the planning, guidance, directives and systems imposed by supervisory headquarters on base level activities, and the manner in which base level activities apply and respond.

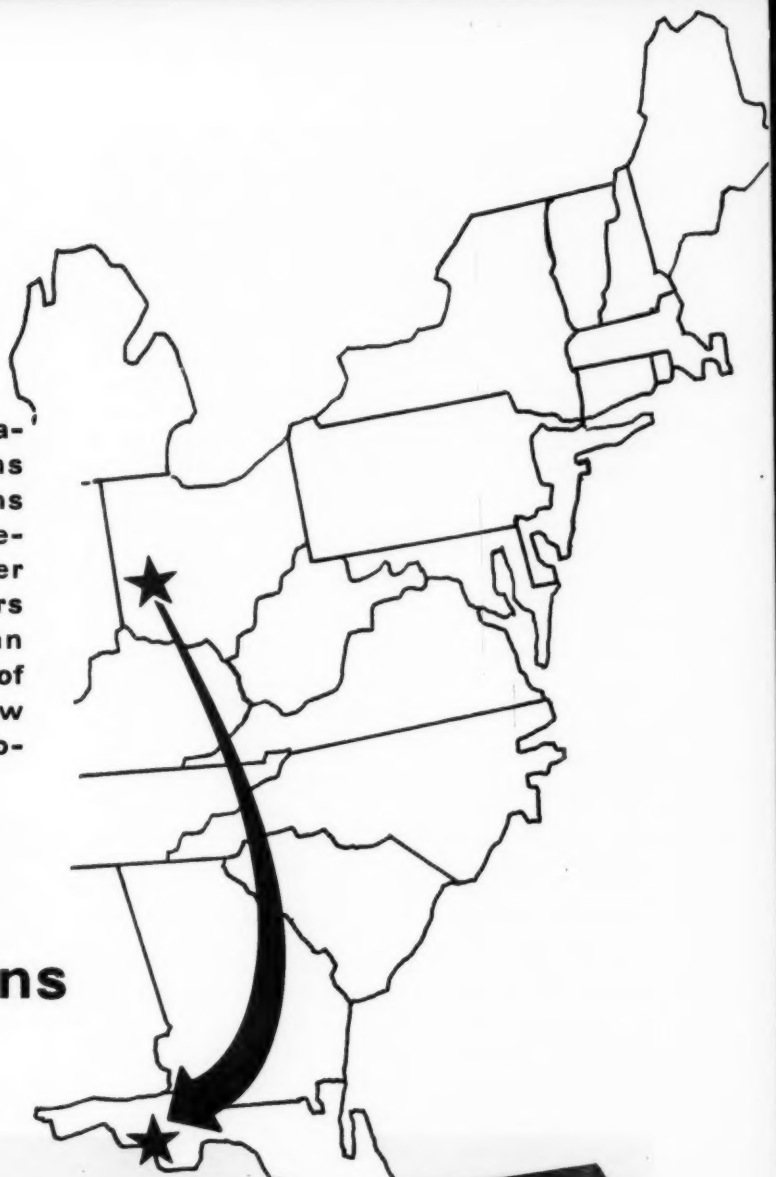
"Much needs to be done in both directions. Our management systems need simplification, and at the same time, supervisors need to be more effective in obtaining higher standards of performance from their people and more efficient in the use made of available resources."

Again drawing from his past experiences, he put forth some interesting observations about the future of AFCE. "I believe the future will bring increased responsibility for accomplishing both design and construction management of Air Force facilities. It will also bring opportunities for increasing the scope of services now performed. For example, CE responsibilities could be broadened to cover other base support areas now split between two or more agencies. Although our primary interest lies in engineering, we should not hesitate to accept additional responsibilities when an improvement in overall service rendered would result."

Born and educated in Illinois, he received his bachelor's degree in civil engineering from the University of Illinois. He entered the military in 1942 as an aviation cadet, and over the years, has garnered his share of decorations. He is a member of the Society of American Military Engineers.

When this write-up began, it was noted that "first impressions are lasting impressions." Applied to Colonel Campbell, ours is just that.

CE



**The 800 mile move from one location to a new base of operations presented some unique problems for the CEC. Sandwiched in between the move came another change: from a Headquarters USAF extension to that of an agency under the command of AFSC. Here's the report on how the AFCEC will continue to provide . . .**

# A Consolidated Effort to Assist CE Organizations Worldwide

by Capt John Pelleck, PE

The Civil Engineering Center dates back to 1 April 1966 when the Civil Engineering Construction Operations Group (CECOG) was organized at Wright-Patterson AFB, Ohio to support civil engineering forces worldwide in areas of RED HORSE and Prime BEEF organizations, training, logistics, airman career development and field testing of equipment and materials. In less than two years, the functions of CECOG expanded many times. An extensive study of the organization of the Directorate of Civil Engineering, Headquarters US Air Force, undertaken in early 1968, indicated that there was an overlapping of responsibilities among CECOG and other Divisions of the Directorate. It was decided to consolidate several operating functions into a field extension of the Directorate similar to CECOG. As the name CECOG was not indicative of the expanded mission, renaming of the CECOG to the Civil Engineering Center took place on 15 May 1968.

As the Center matured, its mission was expanded to provide specialized engineering, technical and planning assistance to complement the integral capabilities of the major air command and base level civil engineering organizations. The Center was responsible for insuring, through establishment of Air Force policy, that civil engineering forces possessed a capability to respond to emergencies and contingencies; that unique services not economically feasible for commands to provide, such as pavements evaluation and corrosion analysis assistance, were made available; and that specialized programs such as civil engineering equipment buys, pre-engineered facility development and fire protection/crash rescue evaluation were satisfactorily carried out.

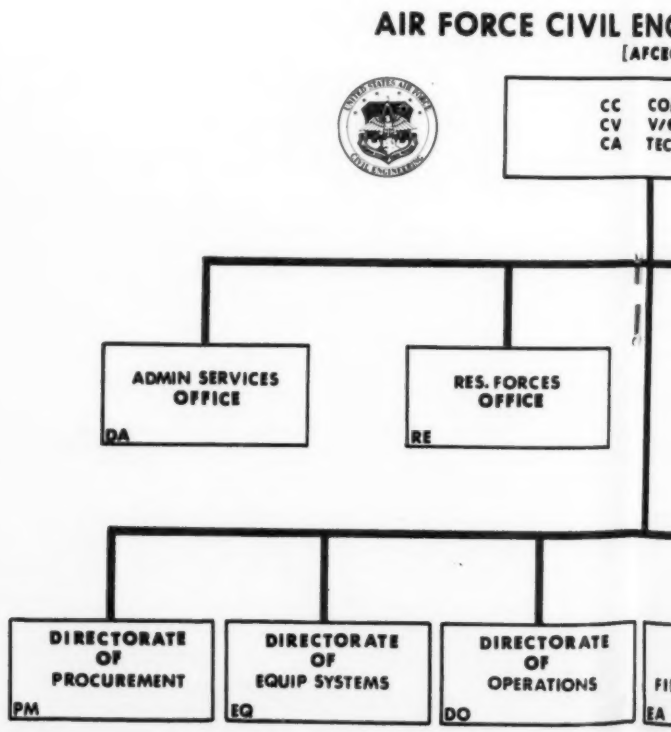
In this capacity, the Center not only established Air Force policy, but also became the "doer" within the organizational structure of the Directorate of Civil Engineering. The "doing" capacity, that is, providing specialized engineering, technical, equipment and planning assistance, etc., is not a normal Air Staff function.

With the expanded role, it soon became apparent that the Center had outgrown its home at Wright-Patterson AFB. Sufficient land areas to effectively support the Center's Prime BEEF and RED HORSE field exercises and engineering testing requirements were not available. Tyndall AFB, Florida, home of Aerospace Defense Command's Air Defense Weapons Center, offered a large amount of undeveloped land and an ideal year-round climate. Thus, on 10 December 1971, the announcement was made that the Center, lock, stock and barrel, was moving south during the summer of 1972.

However, Center personnel had hardly caught their breath from the announcement of the move, when an Air Force study which determined that better effectiveness could be obtained by elimination of Air Staff field extensions, was released. To the Center, this meant elimination of the role in establishing Air Force policy and a transfer of 20 of its 206 manpower authorizations to the Pentagon. It also meant a transfer to Air Force Systems Command (AFSC), where its "doing" role could be expanded and intensified. In AFSC, the Center would more appropriately translate new technology into usable hardware, systems, methods, etc., for worldwide Air Force Civil Engineering.

Along with its new location and major command, the Center's name was changed to the Air Force Civil Engineering Center (AFCEC). The Commander of

Stacking and unpacking boxes of supplies and equipment was a common sight as AFCEC moved into its new facility.



AFCEC reports directly to the Commander of AFSC. Additionally, the Commander of AFCEC is authorized direct communications with Headquarters US Air Force and with major commands on matters related to accomplishing the Center's assigned mission.

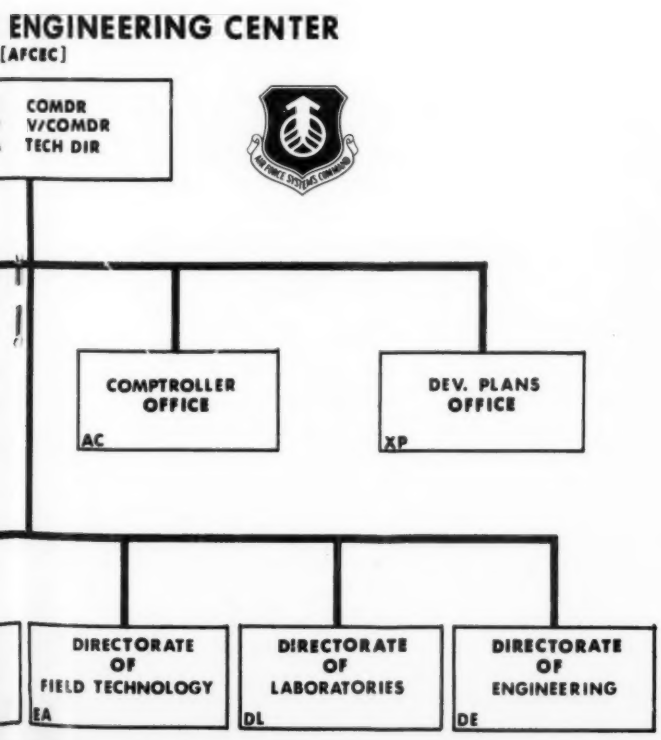
Before the first piece of equipment was shipped to Tyndall AFB, the Center was involved in many arduous hours of planning and coordination. The first item on the agenda for the move was the writing of the Program Action Directive (PAD) 72-1, entitled: "Relocation of the Civil Engineering Center to Tyndall AFB." The objective of the PAD was to insure an orderly move. The underlying theme was that the normal Center functions would not be significantly impaired during the transition period.

The physical relocation to Tyndall AFB was executed in four phases in order to insure optimum mission continuity. They were:

1. A small advance party moved during May and established daily contact with the host base and readied facilities for the other personnel who followed.
2. The preliminary party of 50 personnel reported in June and officially established the Center's functions and operations at Tyndall AFB.
3. The majority of the military and civilian personnel relocations occurred during the month of July.
4. A residual party of eight personnel remained at Wright-Patterson AFB to complete the close-out of operations in August.

Minor problems were encountered during the move, but because of in-depth planning and coordination, these problems were systematically resolved:

- A total of 154 personnel, their families and their households were moved 800 miles south;




**CAPTAIN PELLEK** *is a Prime BEEF Staff Officer, Air Force Civil Engineering Center, Tyndall AFB, Florida. A graduate of the Newark College of Engineering with a bachelor's degree in civil engineering, he received his master's degree in industrial engineering from Texas Technological College. He is a registered Professional Engineer in North Carolina and is a member of the Society of American Military Engineers.*

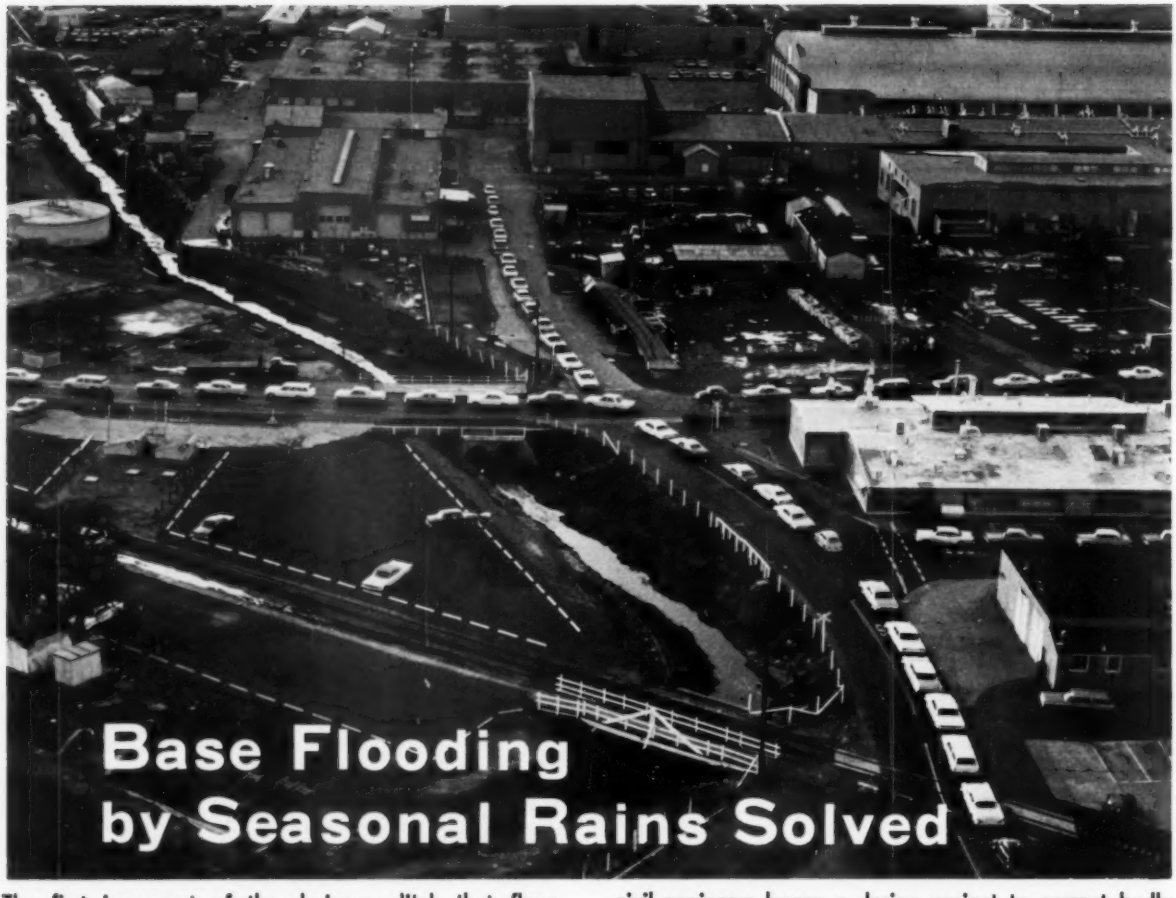
- Additional new personnel reported directly into the Center at Tyndall AFB;
- Offices were manned simultaneously at both Wright-Patterson AFB and Tyndall AFB for approximately one month.

The movement of personnel was a formidable task in itself, but was accomplished without imposing undue personal hardships on the families involved.

Logistically, more than 1,800 items of equipment, varying from desks and chairs to large shop machinery were moved; over one-half million pounds of training aids and supplies were shipped; and more than 100 vehicles ranging from a small jeep to a Hough 400 front end loader were delivered to the new base.

How does the dual transfer of location and command affect Air Force Civil Engineers? First, it provides all commands with a geographical single point of contact for all Air Force Civil Engineering policy matters, the Pentagon. Second, it allows the AFCEC to do **more things better** to serve the user. With expanded training and testing areas and more complete laboratories, the Center will continue to provide specialized services to complement the capabilities of the major commands and base level civil engineering organizations. Further, the Air Force Systems Command mission will allow the Center to expand its role in the engineering development and testing of research efforts to provide the civil engineering field with new products and techniques. This combination of factors will allow all of us to keep "Can Do – Will Do" a reality. CE

**Vehicle operators ease an earth scraper off a flatbed at the Field Technology Training Site after its 800 mile trip.**



# Base Flooding by Seasonal Rains Solved

The first increment of the drainage ditch that flows through McClellan AFB, California, is shown before base civil engineers began a design project to correct badly eroded banks and the growth of vegetation in the ditch.

by Sam S. Nigro, PE

Every year the same thing happened at McClellan AFB, California. The rains came, the creek rose, the drains backed up and the banks overflowed. Erosion was increasing; damage from overflow caused a constant increase in maintenance and repair costs. The usual maintenance procedure of cleaning out the growth and excavating silt was not the answer. Debris was cleaned up and pipes unplugged. As costs were adding up, patience was wearing thin.

One of the big problems was the ground tules and other vegetation in the bottoms of the ditches which choked the flow of water. A permanent fix had to be made. With over five miles of main drainage channels and thousands of feet of tributary channels on the base, the work of maintaining them in a clean condition was expensive. A design project to make a permanent fix was set up and it was to be completed in stages to match appropriations made every year.

The first increment was to clean as many ditches as possible and to establish a permanent correction to as much of the main channel as possible. In the design, many possibilities were considered that included a complete concrete lining, riprap, an enclosed pipe and several other alternatives. The idea was then considered to use a steel invert from a section of arch-culvert pipe and to line the banks with concrete. Cost of this type of fix was such that a portion of the main ditch could be repaired while the rest of the money could be spent on removal of vegetation from other major ditches throughout the base. A contract for the first increment was awarded in June 1967, and it was carried out successfully by the contractor. In 1969, an additional portion of the main ditch was repaired in the same manner and additional cleaning was done in the tributary ditches. The same contractor conducted all work.

The third increment was designed in the same manner and, although a different contractor was awarded this contract, the operation was the same and was accomplished in September 1970.

Experience learned from the first and second contract indicated that the design was quite successful

and was producing results even better than expected. A slight variation between the first two contracts and the third was that instead of lining the banks with cobbles, the third increment used a thicker concrete slab on the banks with wire reinforcing and no cobbles behind it. The contractor requested this variation in order to save time so he could place the concrete before the rainy season started. This was a no-cost change request and it was accepted.

Design features of this type of corrective action included excellent low water flow characteristics with low erosion and economical high water section. It is expected that the life of this canal lining will exceed other types of canal linings. The important feature of this design is a corrugated metal invert made of the lower portion of any standard arch-culvert, multiplate pipe. The use of this type of invert permits ease of fabrication on the job site and ease of placement in the stream without dewatering. It is fabricated on the ground adjacent to the ditch, picked up by crane, placed in the channel and bolted to the previous section. This is done during low water periods and presents no problem to the workers. The metal is 26 gauge galvanized iron and is expected to resist erosion for many years.

### Lining Drains Water in Canal

The principle of the lining is not to be watertight, but to drain the water in the canal. Weep holes are made by leaving out bolts from their normal fabrication pattern at regular intervals. On both sides of the rolled edges of the metal lining, cobbles are placed to fill the void between existing bank and the lining. The cobbles provide stability to the invert and a base for pneumatically placed concrete. The cobble base is made up of a maximum of six inch and minimum of two inch sizes. When the banks are lined with rock, they are placed a minimum of six inches thick. Some hand placement is required to make the lining a dense mat. The pneumatically placed concrete is used as a finish surface over the rock base and is tied to the metal invert lining with anchor bolts extending from the lining edge. When a rock base is used, a minimum concrete thickness of two inches is placed. No wire fabric is used over rock base.

In the third increment, a four inch thick layer of concrete was placed directly on the banks with no rock base. A wire fabric was used. This method proved quite successful since there were so many variations in the slopes and shapes of the existing banks. Many drain pipes extend into the canal from adjacent shops and numerous small drainage channels empty into the canal from the surface of adjacent areas. Several large tributary canals also drain into the main canal. Wherever these tributary drainage sources occur, concrete is extended into these canals to form smooth openings to reduce erosion. In some cases, one bank was con-

*(Cont'd on page 29)*

**This before and after comparison of the drainage ditch at McClellan AFB shows the dramatic impact of good engineering technique. The upper photo depicts the vegetation and eroded condition before work began. Bottom photo reveals completed section of the ditch after work.**

**SAM NIGRO** *is a Civil Engineer in the Base Civil Engineering Design Section, McClellan AFB, California. A graduate of Iowa State College with a bachelor's degree in civil engineering, he is a registered Professional Engineer in California. He is a member of the McClellan Society of Professional Engineers.*

# Worth Noting

## AFIT to Offer Master's Degree in Facilities Management for AFCEs

The Air Force Institute of Technology (AFIT) is preparing to offer a master. of science degree in Facilities Management, by request of the Civil Engineering Panel of the Air Force Educational Requirements Board. The program of study will be similar to management or engineering management programs offered by many civilian universities. It is unique because the entire program is specifically designed to equip graduates to function as senior managers in Air Force Civil Engineering.

The program will be 12 months in length and will be taught at Wright-Patterson AFB, Ohio, where students will be able to utilize all normal base facilities and service. Students must have an undergraduate degree in engineering or in a physical science, mathematics, economics or business administration or a degree from a service academy. Minimum math required for entrance is college algebra. A grade point average of 2.5 on a 4.0 point scale is required. The minimum qualifying grade point average may be lowered on an individually considered basis if prospective students score high on a Graduate Record Examination Aptitude Test or the Admission Test for Graduate Study in Business.

In addition, all instruction is based on the premise that the student has a minimum of three years of sound experience in the Air Force Civil Engineering career field. While it may be some time before the new degree program will be well known to Education Officers at base level, interested officers may submit a request for evaluation immediately and in accordance with **AFM 50-5.** Telephone inquiries should be directed to the AFIT Admissions Directorate, Autovon 78-56231.

## ATC Now Accepting Applications for Vechicle Management Training

A formal training course for Vehicle Control Officers and NCOs has been developed by Headquarters Air Training Command (ATC), Randolph AFB, Texas. The course is designed to train personnel to effectively manage the vehicular fleet. It will be listed in **AFM 50-5** as 2ASR60370, Motor Vehicle Management (PDS Code QKV), with a proposed first class starting date of 1 May 1973.

The course is designed to accommodate 12-13 students per class and will consist of 48 academic hours to be covered over a period of eight days. Civil engineering activities should submit their training requirements to ATC as soon as possible on AF Form 403, Request for Special Technical Training, in accordance with **AFR 50-9,** Special Training.

## Twenty Selected for Promotion to Rank of Colonel in AFCE

The following 20 Air Force Civil Engineer lieutenant colonels were recently selected for promotion to the rank of colonel:

Samuel A. Biondo, HQ AFCS; Robert L. Carey, BCE, Clark AB, Philippines; Robert A. Carlone, AF/PREP; Jerry J. Deluca, HQ PACAF; Louis F. Dominguez, AF/PREP; Roland R. Garren, Arnold Engineering Development Center; Robert N. Gifford, BCE, Ent AFB; William C. Giltner, HQ ADC; Robert C. Harding, 1141 Special Activities Squadron, Stuttgart Germany; Harry H. Magazu, Offutt AFB.

Elo Mussetto, AF/PREN; John R. Osborn, BCE, Grand Forks AFB; Albert W. Owens, 2849 AB Gp, Hill AFB; Donald S. Robb, Yokota AB, Japan; Arlie K. Roesener, BCE, Plattsburgh AFB; George Rokuhara, CINCPAC; Robert E. Ross, HQ TAC; Gerald D. Sjaastad, Air Force Academy.

The above named were selected from the primary zone. Two were selected below the zone and they are Melvin G. Alkire, BCE, England AFB, and Clifton D. Wright, Jr., HQ USAFE.

## L. E. Turner, Davy Crockett Named to New Posts in Secretary's Office

Personnel changes within the Office of the Secretary of the Air Force and of considerable interest to Air Force Civil Engineering personnel were announced recently.

Mr Lewis E. Turner was appointed Acting Assistant Secretary of the Air Force (Installations and Logistics).

Mr Rufus L. (Davy) Crockett, formerly Associate Director, Directorate of Civil Engineering, was named to replace Mr Turner, and now is the Acting Deputy Assistant Secretary of the Air Force (Installations).

Both position changes were effective 1 October 1972.

**Aircraft hangars are changing. In the near future, many large maintenance hangars with their high bridge cranes will need complete structural analyzation. The following is an example of how the Air Force gets . . .**

# Better Engineering Using the Computer

**by 1st Lt Robert R. Costigan, EIT**

Each year, base level civil engineers are called upon to perform more work with fewer personnel and even lesser funds. Therefore, it is important that design engineers fully utilize every available resource. Air Force Logistics Command (AFLC) bases are currently doing this with its usage of the Computational Resources for Engineering and Simulation, Training and Education (CREATE) Computer System. The CREATE system consists of a large scale time-sharing computer, communications network and remote devices at the various AFLC bases. It provides greatly needed design computational support to base engineers, who previously had only the electronic desk calculator to help solve highly complex, time consuming engineering problems.

The CREATE system permits the individual at the base to fully develop, debug, construct data files and execute programs. Many readily learned programming languages are available to the user, such as FORTRAN, BASIC, ALGOL and Time-sharing FORTRAN. Besides the capability to develop individual programs, many standard mathematical/engineering and statistical programs are already available in the system's library with their number increasing daily. These include such programs as Critical Path Method, curve fitting and regression, and geometric and plotting programs. This dual system gives the engineer the broad capability needed to quickly and efficiently solve complex engineering problems.

An applicable example of Air Force wide use of this new computer system by AFLC base engineers to save both time and money is in the area of Structural Engineering, specifically overhead heavy material handling systems. Base engineers are constantly presented with the task of installing new or modifying existing overhead handling systems such as monorails and bridge crane systems. Often, these modifications are in large buildings or aircraft maintenance hangars that have had the systems changed several times over the past years, either because of changes in the base mission or aircraft configuration. Whether with the installation of new overhead handling systems or with the modifications in the configuration and capacities of existing systems, Base Civil Engineering must determine if the existing structure can safely carry the

*(Cont'd next page)*

# Using Computer *cont'd*

new loading conditions. In many instances in the past, this task resulted in short suspense dates for the civil engineer. Since aircraft configurations are changing, many large maintenance hangars with their high capacity bridge cranes will need complete structural analyzation in the near future.

For those personnel unfamiliar with structural engineering some facts follow which give an insight into the problems associated with this task. Manual structural analysis of large aircraft hangars or buildings are far too time consuming to be performed by base level engineering personnel: Each loading condition and combination has to be done separately, and any variation in the location of a load necessitates reaccomplishment of the analysis. Ever increasing work loads coupled with an ever shrinking engineering organization have, in the past, left the base engineers with one of two choices.

The first choice was to spend Architect-Engineer (A-E) funds to perform the structural analysis. The second choice available was a cursory analysis of structural members that might be overstressed in their present configuration once the new loads were applied. The depth of this manually computed analysis depended on available design time allotted to the project. The design would "beef up" these elements, adding a safety factor since this was just an educated guess. Once the new loads were applied, other members deemed unimportant could exceed their allowable working stress, and the "beefed up" members may have taken the new load safely with no change in their configurations. Unless the total structural system is analyzed, the engineer is never certain of his design approach. Decreasing budgets do not allow for the expenditure of funds on the unnecessary strengthening of truss elements. Those truss elements that may become overstressed, however, present a great potential for danger.

The base level engineer now has a third alternative; it not only is more exact and thus safer, but can even save time and money over the A-E choice. This new alternative is the Structural Engineering System Solver (STRESS), developed by the Massachusetts Institute of Technology (MIT). STRESS is available through the CREATE system and can be easily obtained for any new computer system acquired by other commands. STRESS has been used to rapidly analyze highly indeterminate structures, large trusses and space frames with many varied loading conditions. For years, A-E firms have used STRESS to reduce the cost of structural analysis of large projects.

STRESS is a computer system that provides the engineer with the necessary tool for solving problems in structural engineering. It can perform linear analysis of elastic, statically loaded, framed structures, that is, structures composed of slender members which can be represented by their centroidal axis and analyzed with flexure theory. It can analyze two or three dimensional structures whose members and joints may be pinned or rigidly connected. The input data for the program includes joint coordinate locations, member properties such as area and moment of inertia, moment releases for pinned members, load sizes and load locations. The output obtained may contain member forces, axial loads, shear loads, bending moments, support reactions and displacements, joint displacements, and member distortions for each specified loading condition. These member forces can then be converted to the appropriate stresses following the **AISC Steel Construction Manual,** Seventh Edition. An extra recently added to the system library is a computer library program that can use the output of STRESS to determine the size of a beam-column by solving the interaction equation for combined stresses in beam-columns.

The size limitation for STRESS is not more than 250 members and 125 joints per program. However, any number of loading conditions and combinations may be specified through the availability of three sizes of STRESS programs in the CREATE system. The output of the program may be obtained through the local time-sharing terminals or processed on high speed printers and mailed to the user.

The program input with all the descriptions and loading conditions can be permanently saved on paper tape at the remote terminal. In the future, when a building's structural system is modified and a new analysis is needed, the paper tape is fed into the computer (no need to retype the entire program again) and only those loading conditions that need to be changed are typed into the computer. The new loading condition can be added within minutes; therefore, little time is needed to perform a completely new structural analysis after the first is performed. If the program could not be saved at the base level, many hours would be wasted retyping the entire problem each time a new structural analysis was necessary.

A specific example of this new technique is Building No. 125 at Robins AFB, Georgia. Several years ago, three high capacity bridge cranes were needed in each dock to more efficiently perform the needed major maintenance on C-130 and C-141 aircraft. The Robins AFB Civil Engineering Division was given the responsibility to determine if the arch trusses in the hangars could withstand these new loads. Not having

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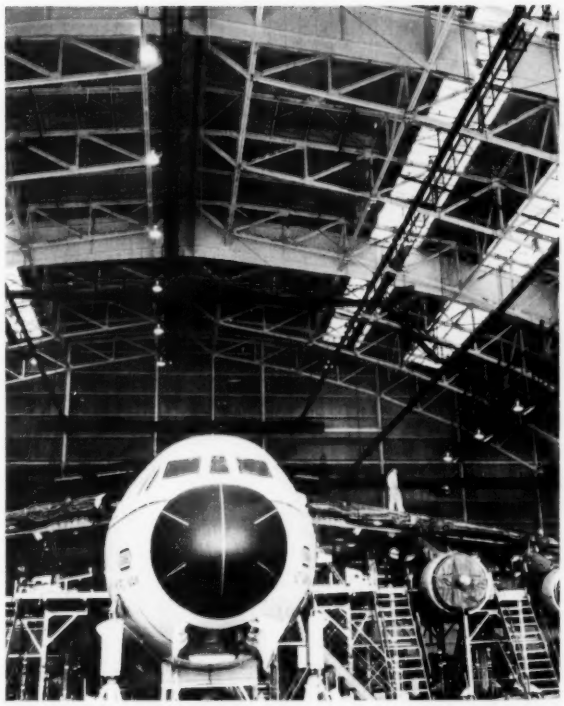
the CREATE remote device at that time, an A-E contract was let to perform a STRESS analysis on the trusses. Engineers at Robins AFB are currently in the process of completely reanalyzing the three hinged arch trusses of Building No. 125, using the STRESS program of the CREATE system. The program for the building will be saved on paper tape. If the bridge crane requires future modification, no A-E contract will be needed. A complete new structural analysis with the modified loading conditions can be input into the remote terminal within a few hours.

There are several advantages of using in-house base level engineers to perform structural analyss. First, is the saving in time. It takes approximately 40 hours to research the average size problem and type the program into the terminal. The engineer need not take the time to consider whether a loading condition and/or combination will cause overstressing. He simply adds this condition to the program in a few minutes and lets the computer determine the answer. More or less time would be required depending upon the size of the problem. During prime time, the computer system will process a specific problem and print out the results within three to four hours and even faster for smaller problems with the majority of this time being teletype output time. To accomplish the entire problem from start to finish would take no longer than the time it takes to write up an A-E contract, select the A-E, send the contract to procurement, undergo contract negotiations and award the contract. Furthermore, the base level engineer is right there at the terminal to make changes and note stress patterns that could substantially reduce the time necessary to solve the problem.

A second advantage is the saving in cost. The average size program is approximately 125 members and 60 joints with 15-17 loading conditions or combinations. To run a STRESS program on the CREATE system for an average size problem will cost approximately $400 during prime time or $300 during non-prime time. This cost includes central processing unit time, teletype time, file storage space, and overhead of the CREATE management section. Add another $200 for the initial research necessary to geometrically describe the trusses in computer language and the total is approximately $500 to $615 for the first complete structural analysis. After the first analysis is performed, new modifications in the structural system would only require changing the location and sizes of these loads, and not the basic truss description which is the major part of the program. Consequently, the second analysis of the building with the modified overhead handling system would not include the $200 needed for initial research. A-E firms will charge between $800 and $1,000 to perform the same STRESS computer computations that the base level engineer can now perform with the CREATE system. This results in a savings of from $185 to $500 for the first structural analysis and between $385 to $700 for future analysis.



Structural analysis of aircraft hangars is made easy with the use of the STRESS program now on the CREATE computer system of the Air Force Logistics Command.

As can be seen from this example, buildings that have changing missions which require modifications to their structural component systems can now be completely and accurately analyzed with a savings in both time and money. The initial problems experienced by the base engineers in mastering the use of STRESS should not be discouraging. Competence with the STRESS program comes quickly with usage. An instruction manual on STRESS is the General Electric Mark II **Structural Engineering System Solver (STRESS), a User's Manual.** It can be found at most AFLC bases either in the Civil Engineering Division or at the base CREATE monitor's office. Other instruction manuals available through the MIT Press, Massachusetts Institute of Technology, Cambridge, Massachusetts are **The STRESS User's Manual** and the **STRESS Reference Manual.**

The intent of this discussion is not to infer that the CREATE system, or similar systems, will replace the need for A-E contracts. On the contrary, the specific expertise of the A-E firms is greatly needed by everyone in the engineering community; however, it is important to show that the base level engineer should use the system when he has the same capability as the A-E firm, and where money and time can be saved by using in-house engineers when possible.

Base level engineers Air Force wide need to become familiar with computerized design and analysis systems and realize the savings in money and time. The savings that result from innovations can not be realized unless they are used.

CE

**The requirement for air pollution source sampling will increase as the various states begin to implement their air pollution control plans under the Clean Air Act. Here's how the Air Force conducts**

# Sampling of Air Pollution Sources at Its Bases

by Maj Ronald D. Burnett, PE

Air pollution source sampling within the Air Force is the responsibility of the US Air Force Environmental Health Laboratory at McClellan AFB, California. It has been recognized by the Environmental Protection Agency (EPA) as competent to conduct independent source tests. Even though the Laboratory is a medical organization, a large percentage of its source sampling work has been accomplished for Air Force Civil Engineering to provide abatement performance data as well as data for designing or selecting pollution control equipment.

This article will present a brief overview of the complexities involved in obtaining a representative sample and accurate sample analysis from a stack; some of our stack sampling experience; and a description of the type of support or source preparation which civil engineering must supply before a sample can be obtained. Hopefully, this background information will provide the Base Civil Engineer with a better basis upon which to determine how and when to use the services of the Laboratory.

### Must Determine What, How Much

Prior to sampling, it is important to determine exactly what and how much information is required. In some cases we have been asked to sample sources to determine compliance when simple visual observations of the exhaust plume would have been sufficient to determine that the emissions exceeded standards. Much time and effort can be saved if local personnel become thoroughly familiar with local regulations specifying limits for visible plumes. Excessive visible emissions are frequently sufficient justification for installation of control equipment.

Data required to determine design, selection or efficiencies of control equipment and to determine quantitative emissions can be obtained only by sampling. Correct sampling technique is the most important factor in obtaining accurate results. More errors result from incorrect sampling than from any other part of the source testing procedures. Usually samples must be collected from sites which are hard to reach, located in hazardous areas and nearly always high above ground, thus further complicating an already difficult task.

The sample location and the number of sampling points are selected to obtain a representative sample. The sampling location should be at least eight stack diameters downstream and two diameters upstream of any flow disturbance (bend, valve, expansion, contraction, fitting, damper, visible flame, etc.) to insure a reasonable uniform flow profile across the stack. In some cases, this means that the civil engineer will have to fabricate and install an extension to the existing stack.

### Ports Must Be Cut Into Stack

After the sample location has been determined, a sampling port or ports must be cut into the stack. **Figure 1** shows the locations of typical traverse/points.

Normally, it is required that two ports be cut into a circular stack 90 degrees apart with two and one-half inches nominal schedule 40 pipe couplings welded flush to the inside of the stack and extending three inches outside the stack. This provides ports of sufficient diameter to allow easy sampling and the pipe coupling provides support required for some of the sampling apparatus. Obviously, a rectangular stack would require a greater number of ports. Some type of support structure extending from the ground or base of stack to the sampling ports is necessary so that equipment and personnel have easy access to the sampling ports. Painters scaffolding is usually adequate. Photographs of typical source sampling operations are shown throughout this article, using various scaffolding configurations, both temporary and permanent.

**TABLE I AIR FORCE SOURCE SAMPLING EXPERIENCE**

| COMMAND | HEATING PLANTS | | | INCINERATORS | INDUSTRIAL PROCESS EXHAUSTS |
|---|---|---|---|---|---|
| | OIL | GAS | COAL | | |
| AFLC | 2 | 2 | 15 | | 18 |
| SAC | | | | 6 | |
| TAC | | | 3 | 1 | |
| ADC | | | 4 | | |
| DASA | | | | 5 | |
| ACIC | | | | 2 | |

Electrical power (110v, 30 amp) must also be supplied at the base of the stack to operate the sampling equipment. On several occasions this has been a problem because circuits which were already loaded to the maximum have been used, resulting in tripped circuit breakers or blown fuses. If possible, a temporary circuit should be provided solely for the sampling equipment.

After all the support functions have been completed, the laboratory source sampling team can begin its work. Gas velocity and temperature measurements are required to determine the stack gas flow. Gas velocities are determined by measuring the velocity pressure (total pressure-static pressure) at each traverse point with type S (stauscheibe) pitot tube connected to a manometer. A pitot tube manometer assembly is shown in **Figure 2.** Stack temperatures are determined in conjunction with velocity pressures using standard thermocouples and dial readout pyrometers.

### Weight of Stack Gas Must Be Determined

In order to determine the actual velocity and volume flow of the stack gases, it is necessary to determine the average molecular weight of the stack gas. This requires that $CO_2$, $O_2$, CO and water vapor concentrations be determined. This is accomplished by collecting a volume of stack gas proportional to flow at each traverse point in teflon bags. The $CO_2$, $O_2$ and CO concentrations are then analyzed from the bag sample using Orsat or nondispersive infrared analyzers. The moisture content of the stack gas is determined separately by condensation methods. **Figure 3** shows a typical moisture sampling train.

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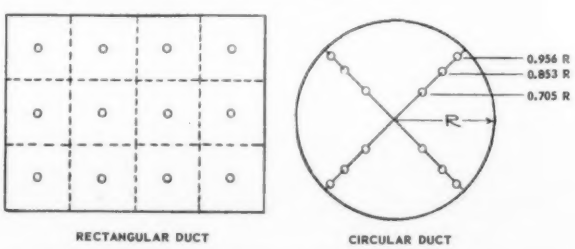
FIGURE 1 — Traverse Point Locations




**MAJOR BURNETT** *is the Chief, Environmental Engineering Branch, US Air Force Environmental Health Laboratory, McClellan AFB, California. He received his bachelor's degree in chemical engineering from Texas A&M University and his master's degree in environmental engineering from Harvard University. A registered Professional Engineer in Texas, he is a member of the American Industrial Hygiene Association.*

FIGURE 2 — Pitot Tube Manometer Assembly

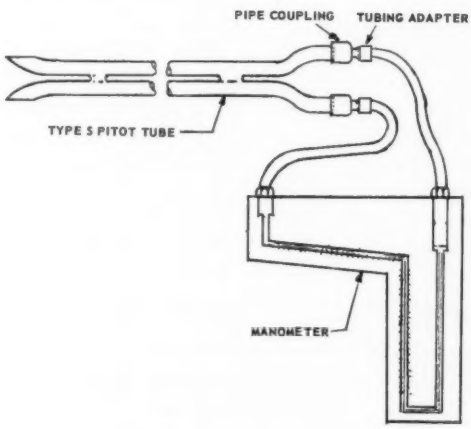



FIGURE 3 — Moisture Sampling Train

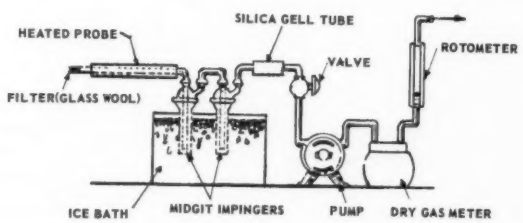
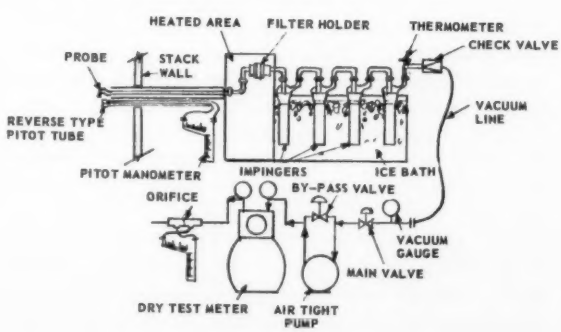



FIGURE 4 — Particulate Sampling Train



# Air Pollution *cont'd*

When other gas concentrations such as sulfur dioxide and nitrogen dioxide are required, separate sampling trains are used and analysis is accomplished by wet chemistry methods.

Sampling for particulates is much more difficult and require more sophisticated sampling apparatus. A representative particulate sample can be obtained only if the sample collection velocity is equal to the velocity of the stack gas at the sample point. This is termed isokinetic sampling. Normally we try to collect samples within plus or minus 10 percent of isokinetic at each traverse point.

The sampling train used by the Air Force is the same as that recommended by EPA and is shown schematically in **Figure 4.** This sampling train with certain modifications, depending on the type source, is used for essentially all particulate emitting sources. The particle concentrations are determined by weighing the particulates collected in different portions of the train.

Usually a majority of the analytical work is accomplished at the laboratory; however, sample train clean-up, some gas analyses and determination of stack gas moisture concentration is accomplished in the field. Thus, the base must provide a small room (-100 $ft^2$) in close proximity to the stack with electrical power and running water for use as a field laboratory.

In one case all the analytical work was accomplished in the field because the results were required on short notice.

### Sampling Includes Heating Plants, Incinerators

Our stack sampling experience includes primarily heating plants and incinerators. We have also had some limited experience sampling jet engine test cells and industrial process exhaust systems such as plating processes and degreasers. A summary by Command is shown in **Table I.**

One stack sampling test which includes a minimum of two 1-hour sampling runs and one preliminary run requires a team of three to five personnel depending on the complexity of the tests. A stack test including equipment set-up, sampling and equipment pack-up requires a minimum of three days. The time per stack is somewhat reduced if more than one stack is sampled at a given base. For example, five stacks can usually be tested in a 10 to 12 day period if two sampling teams and two separate sets of sampling equipment are used.

It is extremely important that the Laboratory be given at least 90 days notice prior to the date the source test is desired to allow sufficient time for scheduling. Also it must be kept in mind that essentially all tests must be accomplished at the maximum operating capacities of the units being tested, thus boilers and heating plants must usually be tested in the winter so that maximum steam can be generated. When testing incinerators, sufficient waste for three or four tests at maximum capacity must be available, bundled into packages for convenient loading and each bundle must be weighed prior to the tests.

The unit to be tested, including existing air cleaning equipment must be properly adjusted and in good operating condition if a valid test is to be performed. On several occasions we have been asked to accomplish tests on units that were in such poor repair that it was impossible to operate the unit in accordance with design specifications. This is wasted time and effort as test results are invalid as soon as the needed repairs are accomplished.

As the states begin to implement their air pollution control plans under the clean air act, the requirement for source sampling will increase. In anticipation of these increased sampling requirements, it is suggested that sampling ports and platforms be included in the stack designs for new sources being constructed under Air Force contracts. It is quite possible that many of these new state implementation plans will require that suitable sampling locations and facilities be provided on new units. **CE**

Workmen use painters scaffolding to conduct a sampling test of this coal fired heating plant.

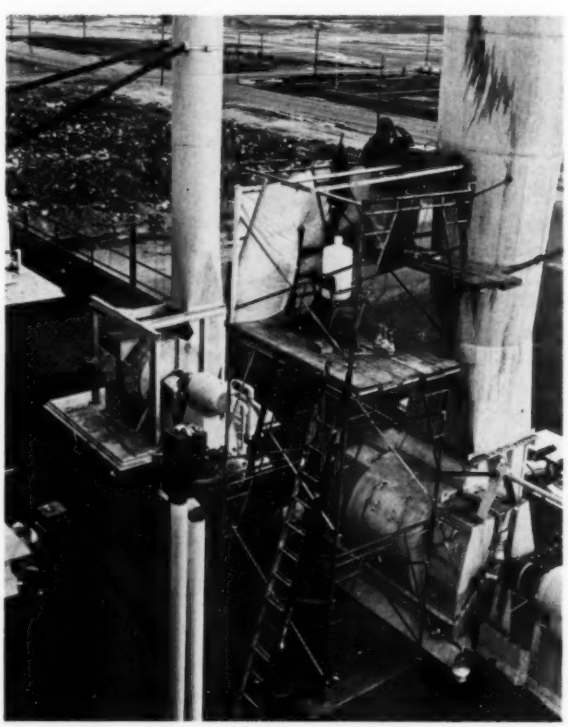


Figure 1: Cavitation occurs at bottom portion of liners in an area perpendicular to crankshaft centerline.

**A widespread phenomenon that has been experienced in many diesel engines operating in the Air Force is called cavitation, the erosion of diesel engine cylinder liners. Research at Thule AB has proved that the problem can be eliminated.**

# More Consistent Generator Power for Base Facilities

by Ernest G. Huber, PE

Water-side deterioration or cavitation-erosion of diesel engine cylinder liners is a widespread, complex phenomenon that has been experienced in many engines operating within the Air Force. In several instances, cylinder liners have had to be replaced not because of internal wear but because of progressive cavitation damage at the cylinder water side. In some cases, cavitation progressed completely through the liner wall, causing the coolant to leak into the cylinder and crankcase, and thus contaminate the engine lube oil. Such leaks are difficult to detect before damage occurs to internal wearing parts.

### Not Confined to Any One Design

Replacement of cylinder liners is particularly costly for large engines, is time consuming and results in the extended loss of the unit as a power producer. The destructive forces of cavitation are not confined to any one design, make of engine or geographical location, although its attack is clearly evident in certain diesel models and practically non-existent in others. In most cases, cavitation occurs at the bottom portion of the liners in an area perpendicular to the crankshaft center line (piston thrust side, **Figure 1**). However, many liners show severe cavitation attack at the liner top portion, **Figure 2.**

Considerable research has been conducted over the years by private industry and Federal agencies to determine the cause of, and solution to, this problem. Results of this research yielded general agreement that cavitation is a mechanical damage caused by the pounding effect of collapsing vacuum bubbles generated in the engine cooling fluid. Chemical or electro-chemical action (corrosion) was also suspected, but was ruled out as a major cause, since this type of attack would occur more generally over the entire liner surface rather than at individual (isolated) locations. The theory is that the vacuum bubbles, causing dynamic pitting (termite action) at the liner water-side surface, are generated by high frequency vibration of the liner. *(Cont'd next page)*

# Generator Power

*cont'd*

Research also established that cavitation damage begins to appear when the amplitude of vibration equals or exceeds 0.003 inch. Occurrence of high frequency vibration of the lower portion of the liner can be explained as follows: The upper end of the liner is clamped down onto the cylinder block by the cylinder head. The lower portion is loosely fitted in the cylinder block at the rubber seal ring area and is free to resonate (tuning fork effect). As the piston moves up and down in the liner, reversing its thrust from one side to the other, liner vibration is constantly sustained. However, this tuning fork effect does not hold true for the upper, clamped-down portion of the liner where cavitation damage has also been observed, **Figure 2.**

### Creates Vacuum Bubbles

The theory is that this portion of the liner is subjected to intense high-pressure pulses (firing pressures) and if the wall thickness of the liner is too light, it will expand radially (breathing) at every firing pulse, thereby creating vacuum bubbles similar to those generated by vibration.

In 1964, the Air Force initiated a research program at Thule AB, Greenland, which, with its unique configuration of eight separate diesel power plants, lent itself favorably for this kind of research. Severe cavitation damage had previously occurred in all engines and at all eight plants, cavitating not only the cylinder liners but also the cylinder block casting. The research program called for operating each plant with a different cooling solution and to periodically check the effect it had on cavitation. The solutions proposed for trial were sodium nitrite borax, a mixture of water and emulsifying cutting oil (water-soluble oil). Sodium chromate solutions which are known to be excellent corrosion inhibitors, were not tried because of their toxic nature and incompatibility with ethylene glycol. In addition, cylinder liners at some plants were painted on the outside with a zinc-chromate paint; others were painted with an epocast material. This latter material was also applied to the liners at the lower water sealing area in an attempt to reduce the clearance between liner and block, and thereby reduce the amplitude of vibration of the lower liner portion.

Figure 2: A close-up view of a liner that shows severe cavitation attack at the liner top portion.

While the different coolant solutions tested in the Thule AB engines had some beneficial effect in retarding cavitation, only the sodium-nitrite-borax solution was capable of completely arresting/eliminating cavitation.

Sodium nitrite-borax is a commercially available granular mixture composed of three parts of sodium nitrite and one part borax. To prepare the desired engine coolant, about four pounds of sodium nitrite-borax are added for each 100 gallons of cooling system capacity or an amount sufficient to raise the pH value of the coolant fluid to about 9.0. Sodium nitrite-borax is fully compatible with antifreeze solutions such as ethylene glycol.

After operating the engines at Thule AB for more than 8000 hours with the sodium nitrite-borax coolant mixture, no trace of cavitation could be detected.

In conclusion, it is not known why the addition of sodium nitrite-borax to the engine cooling fluid eliminates cavitation, but what is known, IT WORKS.

CE

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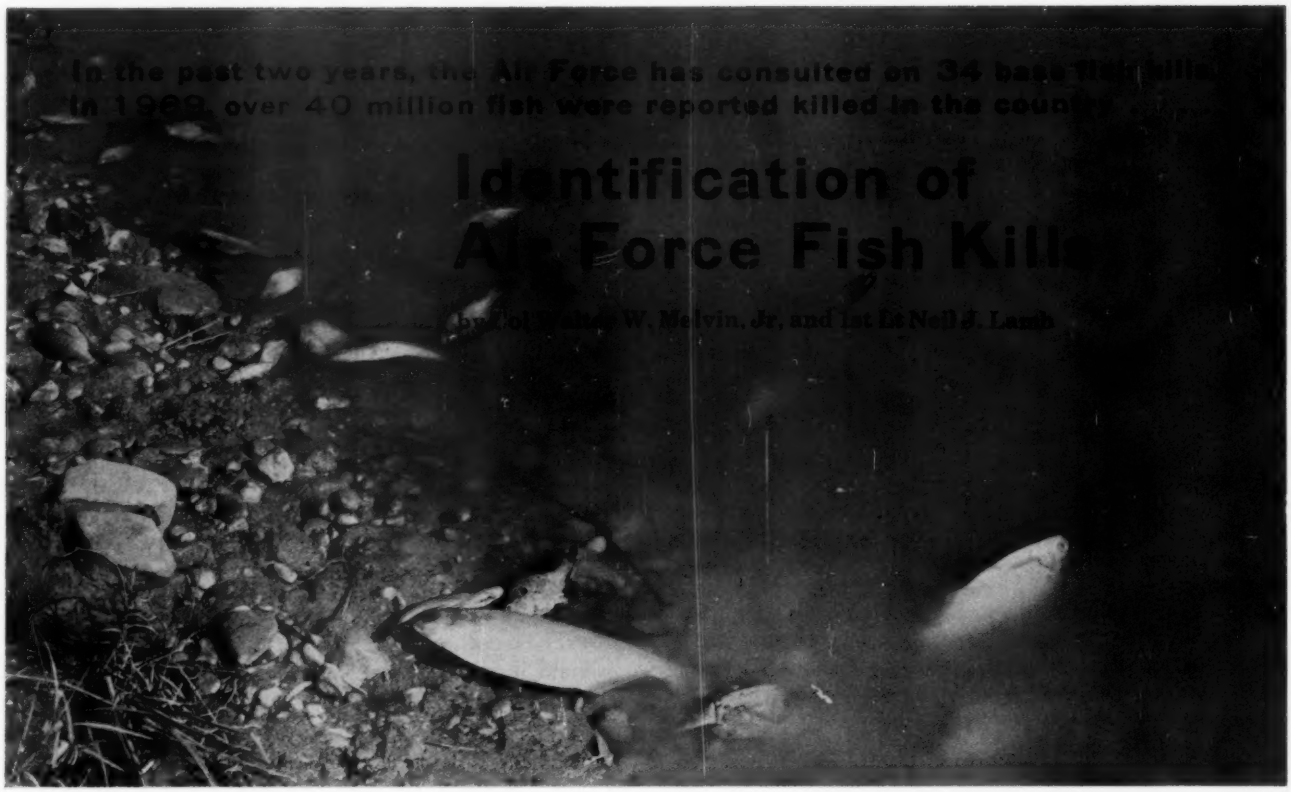

# Identification of Air Force Fish Kills

by Capt Robert W. Melvin, Jr. and 1st Lt Neil J. Lamb

At 1600 hours, the telephone rings in the office of the Base Civil Engineer (BCE). The caller announces: "Fish are dying along the stream that flows through the golf course." For the BCE, the routine of the hot July afternoon is broken. What should he do first? Who should he call? How does he evaluate the fish kill?

Water quality is an area of growing public awareness. The species and number of fish living in a stream or pond reflect the general quality of those waters. Fish kills are deplored by all people who appreciate nature. They can also result in bad publicity and litigation. The base investigator must act quickly to gather the necessary information and samples to resolve the kill. Accurate and prompt identification of the cause of the fish kill can limit the extent of the kill and often prevent subsequent similar occurrences. An understanding of the fish kill may initiate pollution abatement and a routine monitoring program.

Fish kills vary in types and extent. Most fish kills associated with Air Force bases are directly the result of operations or waste discharges. Over 40 million fish were reported killed in the U.S. in 1969, almost all due to man. The US Air Force Environmental Health Laboratory (EHL-K) at Kelly AFB, Texas, has consulted on 34 base fish kills in the past two years. Oxygen depletion is the most common cause of fish kills. Most fish require greater than four mg/1 dissolved oxygen in the water for survival and productivity. Toxic waste discharges are the next most common cause. A few fish kills are the result of natural phenomena.

Oxygen depletion results from the discharge of chemical or organic wastes to waters where the dissolved oxygen is used by microorganisms in the decomposition of these wastes. Eutrophication of the waters by nutrients can also deplete the dissolved oxygen.

Industrial and domestic wastes contribute toxic substances to the environment. There are two types of toxicity:

1. Chronic toxicity is an insidious problem that may go undetected for long periods. Such factors as reproduction, longevity and food organisms may be affected. Fish mortality may be distributed over such a long period of time that no kill is noticeable. Stream surveys by aquatic biologists can determine if chronic toxicity has affected the aquatic biota.

2. Acute toxicity is obvious and dramatic, but often difficult to solve. These fish kills result from accidental spills or abnormal discharges of pollutants that exceed the concentration tolerated by the indigenous species for even a short time.

Man has changed the environment so extensively that he also causes fish kills from temperature changes, abrupt water level fluctuations, salinity changes, siltation and pH changes.

Some of the causes listed above can result from

*(Cont'd next page)*

# Fish Kills *cont'd*

Kelly AFB personnel conduct field surveys to investigate water pollution problems and fish kills on USAF bases.

natural phenomena. In addition, fish can die from parasites and microbial diseases. Decomposition of natural materials such as leaves, algae and humus can deplete the oxygen. Winter kills result when the dissolved oxygen is exhausted from shallow, muck-bottom waters during prolonged ice cover. A few "fish kills" are not truly kills, but natural die-offs. These include natural death due to old age and death associated with spawning cycles. A guideline for classifying fish kills is shown in **Figure 1.**

All fish kills resulting from Air Force activities should be investigated. The following procedures will apply to most fish kills caused by acute toxicity.

1. When a fish kill is reported, the most competent biologist on base should be called. The Base Bioenvironmental Engineer and Base Veterinarian should also be involved and other base officials notified according to local procedures.

2. Fish kills are most often solved by analyzing the water in which fish are dying. The first field step involves obtaining water samples immediately. This is important because toxicants that enter the water are usually dispersed rapidly. Toxic agents in streams will be diluted fore and aft of a slug moving downstream. Collection and field analyses should be as follows:

- Collect water samples in glass bottles with aluminum foil-lined caps. Do not use plastic containers to collect water samples for pesticide analysis. A two-gallon sample is minimal and larger samples insure adequate volume for extra analyses.
- Quickly and accurately determine the water's pH, dissolved oxygen and temperature.
- The next step is to determine if in fact there has been a significant fish kill and if so, what is the extent of the kill. The investigator should survey the stream or lake, counting dead fish and noting these environmental factors: number of fish and number of species of fish affected; behavior of dying fish; other organisms affected; water color; water level; weather conditions; and algal growths.
- Collect fish, mud and other biological samples, freeze and ship on dry ice. Label and identify all samples.

Moribund, but still living fish should be collected, but recently dead animals are acceptable. Do not send decomposed fish. The recommended size of collections is a minimum of one to two pounds of fish per sample. This would include one or two large fish and up to 10 smaller fish. Specimens of all species affected should be submitted. These should be placed separately in plastic bags, labeled, quick-frozen and shipped on dry ice to the EHL-K.

An important aspect often overlooked is that healthy fish from an unaffected area should be collected and shipped along with the other fish. These will be used as controls for background levels and should be labeled as such.

Bottom sediments from the affected area and from an unaffected area should be collected. Refer to EHL-K Technical Report 71-24, **"Preferred Methods and Techniques for the Collection, Preparation, and Submission of Biological and Environmental Samples to the USAF Environmental Health Laboratory, Kelly,"** July 1971, for collecting techniques. These samples are often helpful in locating heavy metal pollutants.

Contact persons who first observed the kill and note the time when the kill began and when it ended. Obtain a map of the area. Locate all possible sources of wastes and mark water flow patterns. Locate area of fish die-off. Inquire into recent use of pesticides.

Call the EHL-K (Autovon 945-3061 or 945-5198). Samples should be submitted to the USAF Environmental Health Laboratory/Kelly, Kelly AFB TX 78241. Notify the Laboratory of the mode of ship-

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**LIEUTENANT LAMB** *is an Entomologist, USAF Environmental Health Laboratory, Kelly AFB, Texas. Previously, he was assigned as a Medical Entomologist, 5th Epidemiological Flight (PACAF), Manila, Republic of the Philippines. He earned his bachelor of science degree from the Michigan State University.*

ment, name of carrier, estimated time of arrival and shipment control numbers.

**AFR 19-1,** dated 18 February 1971, provides instructions for the reporting of pollution incidents to the Environmental Protection Group (PREV), Directorate of Civil Engineering, Headquarters US Air Force. PREV will coordinate with the Environmental Protection Agency.

A most probable cause of the fish kill may appear obvious to the investigator after he has collected the data and made a survey. However, he should contact a biologist and review the facts with him. Some fish kills can be solved by a phone call to EHL-K. Kills not caused by oxygen depletion or some other physical condition must be investigated for a toxic agent and the source must be found.

Bioassays are run on all water samples as received at the EHL-K for fish kill investigations. The bioassays determine if a toxic agent is still present in the water. Laboratory colonies of fathead minnows (**Pimephales promelas**) and giant water fleas (**Daphnia magna**) are routinely used for fresh water bioassays and brine shrimp (**Artemia salina**) for salt water bioassays. Identification of the toxic agent will be pursued through extensive chemical analyses on all waters found to be toxic.

Gross examination of the fresh fish and tissues can offer visual evidence of some parasites and toxicity problems. However, the accurate determination of the cause of death of fishes is nearly impossible by the use of post mortem techniques. Special prepartion of fish in the field is necessary for pathological and histological examination. The EHL-K is not equipped or staffed to do these evaluations. A specialized biological (aquatic) laboratory should be contacted if a disease is suspected.

1. **MINOR FISH KILL** – 1-100 dead or dying fish are confined to a small pond or stream stretch.
2. **MODERATE FISH KILL** – 100-1000 dead or dying fish in a kill area not exceeding a mile or so of stream or part of a medium size lake.
3. **MAJOR FISH KILL** – 1000 or more dead or dying fish affected over a large area.

**Figure 1: Classification of Fish Kills.**

The emphasis for all fish kill investigations is to collect water samples in the area where the fish are dying. Measuring the dissolved oxygen content of the water at the time of the kill is absolutely essential. The other parameter can be measured and samples collected as soon as possible thereafter. The EHL-K should be consulted for support and interpretation of data. This support includes the loan of equipment, complete water analyses, fish identification, chemical analyses for toxic levels of metals and pesticides in the fish, and an ecological assessment of the incident. Areas suffering from recurrent fish kills and poor water quality should request a biological field survey. The EHL-K is staffed with trained personnel who can analyze the samples and data collected by the base. With this multidisciplinary approach, the probable cause of the fish kill can usually be deduced and corrective action taken to preclude its recurrence. The EHL-K is as close as your telephone. CE

# Base Flooding *cont'd*

siderably higher than the other. Where this occurred, concrete was carried up on the high bank only as high as the opposite low side since overflow would occur at this height.

The top of the concrete was beaded into the bank to prevent undercutting from surface flow. At the top of each bank where the concrete extended the full height, a bead of at least one foot thick was used for the purpose of preventing undercutting by surface flow. The thickened edge also gave additional strength to the edge of the slope where it will be exposed to the possibilities of cracking. The linings were butted to headwalls in the channel where pipes and bridges occurred. In this manner, the work was continuous from headwall to headwall. The transition between the existing headwall and apron and the section of new lining was flared to fit, using pneumatically placed concrete to shape the transition. Where a reach of the new lining did not start at a headwall, a concrete footing approximately one square foot in section was used as an anchor for the steel lining. The concrete wall lining was imbedded at least one foot into the banks, similar to the bead at the top. This was done to prevent undermining the beginning section of the lining. The pneumatically placed concrete used was a standard design mix from a commercial source.

Since the first increment was constructed in 1967, several seasons of high water have been experienced. To date, only a few minor cracks have shown up and no impairment to the flow has been experienced. Approximately 95 percent of the time, the flow in the channel is contained within the section of the steel inverts. High flow extending up into the section of the canal lined with concrete is intermittent and of short duration. No overflow has been experienced since the lining was installed and the flow characteristics have been excellent. Maintenance has been reduced to practically zero and no damage losses have been incurred in the areas repaired.

Costs of this type of corrective action have proven its merit and indicate a high benefit-cost ratio. Also, it is expected that repairs, when needed, will be minor and inexpensive. As each increment is constructed, the base is approaching a maintenance-free condition for surface drainage canals. CE

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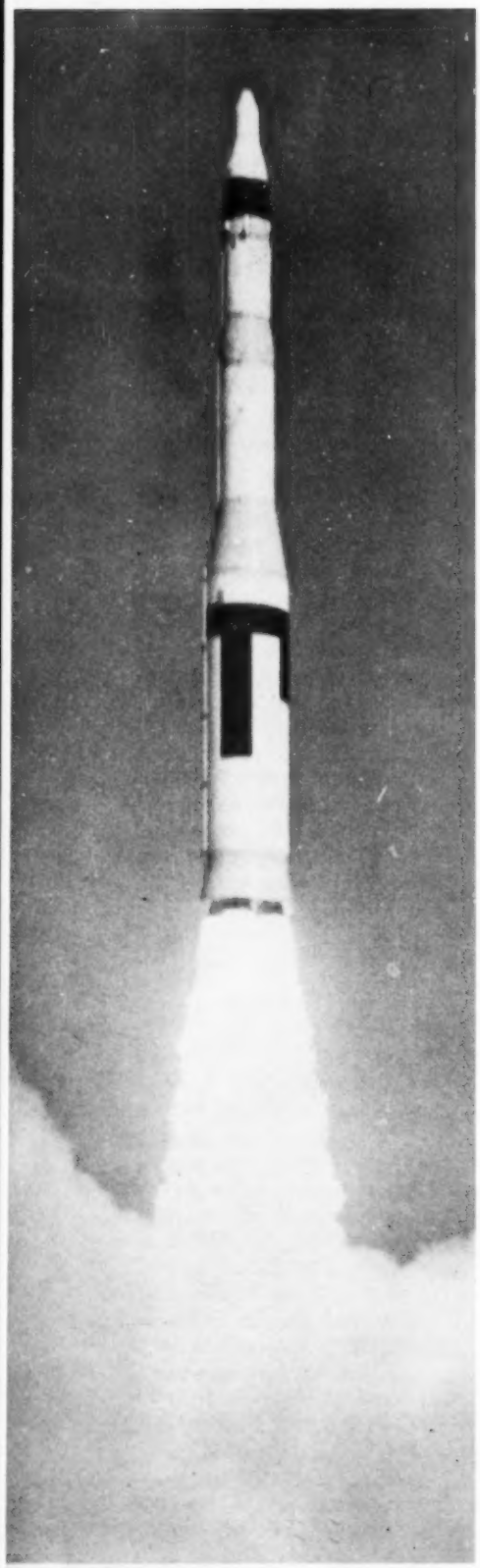

# Professionalism for the Engineer

To an engineer, professionalism involves more than skill. Although knowledge and skill may exist without professionalism, professionalism can develop only where competence creates a proper atmosphere. Competence alone is impersonal. **Professionalism, in contrast, is an individual state of mind, a way of thinking, a way of working and living, a way of adding something valuable on top of competence.** Professionalism is the use of skill and knowledge with honesty and integrity; with one's best effort, knowing that frequently neither client nor employer can evaluate that effort; with avoidance of all possible conflicts of interest; with the consciousness that the profession of engineering is often judged by the performance of a single individual.

Professionalism for an engineer begins with good moral character, because he occupies a position of trust where he personally must set the standards. He must make difficult decisions which may differ from those his company or his client desires.

Professionalism for an engineer means

- striving to improve his work until it becomes a model for those in his field, as a minimum using the most up-to-date techniques and procedures.
- proper credit for work done and ideas developed by subordinates.
- loyalty to his employer or client, always with concern for the public safety, in construction, product design, plant operation, and all other phases of engineering.
- leadership of less experienced colleagues and subordinates toward personal and professional development and an enthusiasm for the profession.
- activity in technical societies in order to keep current in his field, and encouragement of those working under him to improve their technical competence the same way.
- participation also in professional societies, thereby demonstrating his interest in the profession and encouraging his co-workers to recognize the technical and the professional as of equal ranking importance.
- registration, not simply because it may be a legal requirement, but more particularly as a demonstration to his co-workers and the public that this is one important hallmark of a professional, a willingness to go beyond the minimum of help and encourage others to realize their full potential.

Professionalism includes also special facets related to particular areas of practice. For the engineer in government or the engineer in private practice, professionalism means capitalizing a special opportunity to project the profession to the public as a constructive force in society. For the engineer in industry, professionalism means the establishment of performance standards and safety criteria which protect the purchaser while maintaining a satisfactory return to the manufacturer. For the engineer in education, professionalism means practicing at the frontier of knowledge in some field and pushing against that boundary, thus impressing on his students that boundaries need not be and rarely are static.

Professionalism means active participation in community life for each engineer. Engineering can achieve general recognition as a profession only as engineers are visible to others. Professionalism shows up strongest in the realm of civic and public service, particularly in service to the public and community and to those less fortunate.

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